GUIDEBOOK TO THE GEOLOGY OF UTAH

Number 15

GEOLOGY OF THE SILVER ISLAND MOUNTAINS

BOX ELDER AND TOOELE COUNTIES, UTAH AND ELKO COUNTY NEVADA

UTAH GEOLOGICAL SOCIETY

1960

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GEOLOGY OF THE CENTRAL AND SOUTHERN SILVER ISLAND MOUNTAINS

TOOELE COUNTY, UTAH AND ELKO COUNTY, NEVADA

by

FREDERICK ERNST SCHAEFFER, JR.

A thesis submitted to the faculty of the University of Utah in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

Department of Geology

University of Utah

June, 1961

THIS THESIS FOR THE PH.D. DEGREE

by

FREDERICK ERNST SCHAEFFER, JR.

has been approved

June, 1961

Head, Major Department

PREFACE

The thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy of Frederick Ernst Schaeffer, Jr. consists of the following papers and plates in the *Guidebook to the Geology of Utah,* Number 15, 1960: Stratigraphy of the Silver Island Mountains, Igneous Rocks of the Central and Southern Silver Island Mountains, Structural Geology of the Central and Southern Silver Island Mountains, Road Log, Introduction (this paper was coauthored by Warren L. Anderson), plates 1A and 1B — Geologic maps of the Central and Southern Silver Island Mountains; plate 1C — Geologic cross sections of the Central and Southern Silver Island Mountains; plate 3 — Composite stratigraphic section of the Paleozoic rocks in the Silver Island Mountains, Utah and Nevada.

Warren L. Anderson's Master of Science thesis in Geology was completed at the University of Utah in 1957 and entitled "Geology of the Northern Silver Island Mountains." A series of papers and plates by Anderson from his thesis were included in the *Guidebook to the Geology of Utah,* Number 15, 1960 in order that a report of the entire mountain range could be published in one guidebook.

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GEOLOGY OF THE SILVER ISLAND MOUNTAINS

BOX ELDER AND TOOELE COUNTIES, UTAH AND ELKO COUNTY NEVADA

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INTRODUCTION

By

Warren L. Anderson

And

Frederick E. Schaeffer

LOCATION

The Silver Island Mountains are a northeast-trending range extending from six miles west of the Utah-Nevada border near Wendover, to about 32 miles northeast of Wendover, Utah. (see fig. 1) The range is in the northeast part of the Basin and Range Province and is a part of the Great Salt Lake Desert. The Silver Island Mountains are situated in western Tooele and southwestern Box Elder Counties, Utah, and in eastern Elko County, Nevada.

ACCESSIBILITY

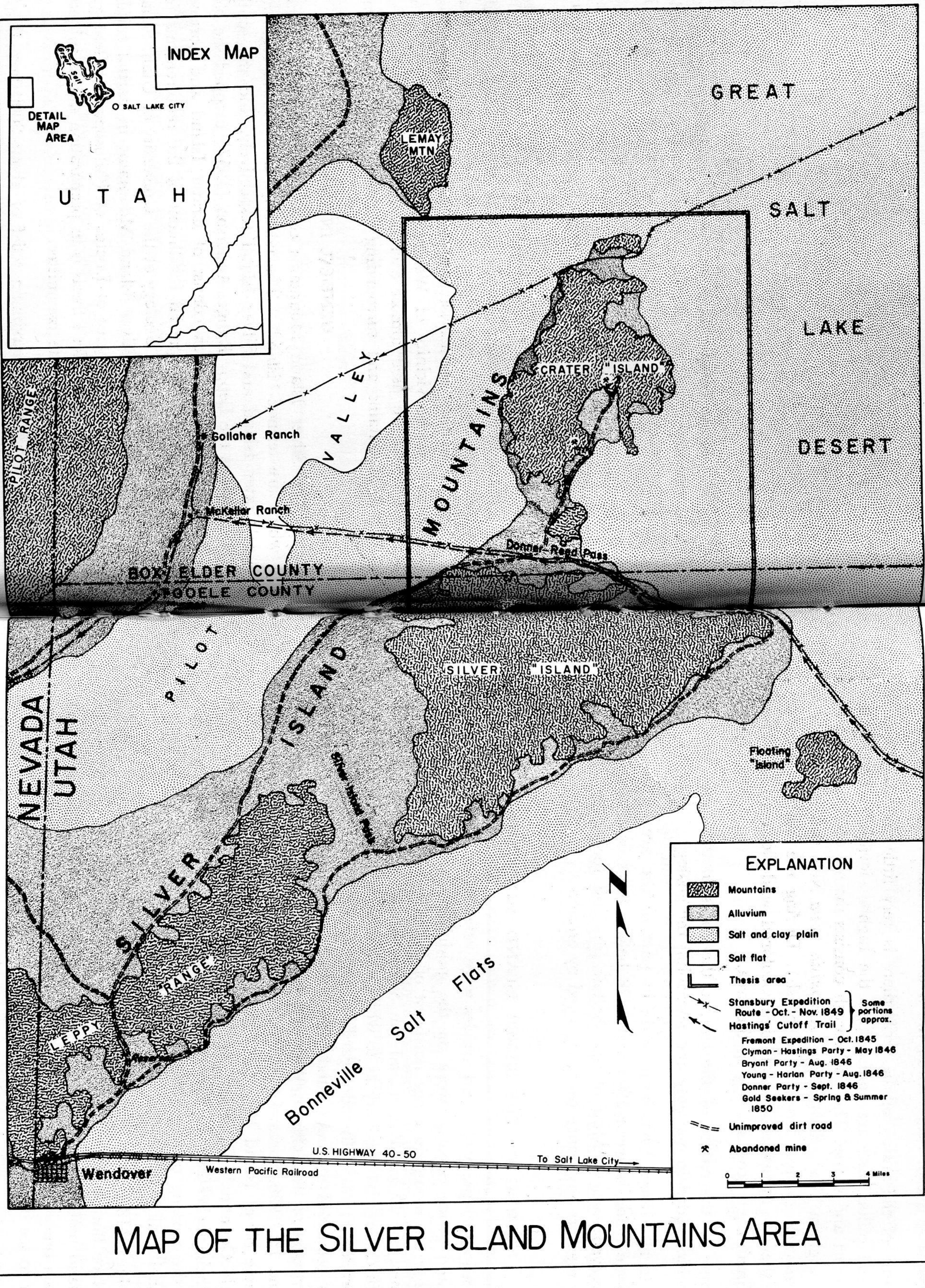
Wendover is located on the Utah-Nevada border on U. S. Highway 40, 50, and on the main line of the Western Pacific Railroad. The Silver Island Mountains are accessible by unimproved dirt and gravel roads which originate in the vicinity of Wendover, Utah (see fig. 1). At present the access roads are used almost exclusively by stockmen, who use the Silver Island Mountains and surrounding foothills as a winter range for sheep.

GENERAL INFORMATION

The Silver Island Mountains consist of three main segments, two of which are termed "islands." The northern and central segments are known as Crater Island and Silver Island respectively, and the southern segment is known as the Leppy Range. Anderson (1957) mapped the Northern Silver Island Mountains, which consist of Crater Island and northwestern Silver Island (see fig. 1) in partial fulfillment of the requirements for the degree of Master of Science in Geology at the University of Utah. Schaeffer mapped the remainder of the Silver Island Mountains in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Geology at the University of Utah. Schaeffer's thesis is in preparation and is subject to the final approval of his graduate committee.

The range has a maximum relief of about 3000 feet, the highest point being 7300 feet, on Silver Island. The highest elevation on Crater Island is 5675 feet. The highest elevation in the Leppy Range is 6698 feet. The Lacustrine plain surrounding the range has an average elevation of about 4220 feet.

FIGURE 1



MAP OF THE SILVER ISLAND MOUNTAINS AREA

The average annual rainfall is probably between 4.83 inches, the average at Wendover, and 5.99 inches, the average at Lucin, Utah.

Because of the aridity of the area, there is very little vegetation. Small juniper and piñon pine are confined to the higher elevations, and underbrush is short and sparse. The underbrush consists mainly of *Ephedra viridis* Coville (Brigham Tea), *Aplopappus, Artemisia nova* Nels (small sagebrush), and *Tetradymia spinoza* Hook (horsebrush). During the Spring and early Summer there is an abundance of highly colored wild flowers and various grasses. Small cacti grow sparsely in the area.

Because of the nature of the climate the rocks in the range are well exposed which aided in mapping and describing the geology.

Cadastral surveys have been made in part of the area. Most of the surveys were made between 1903 and 1908 before brass caps were used to mark surveyed corners. Most of the shallow pits and rock piles then used as corner markers have since been destroyed by erosion.

NAMING OF THE SILVER ISLAND MOUNTAINS

As various maps, books, and articles were referred to during the course of field and office research work on the guidebook area, it became very evident that the mountain range northeast of Wendover had two commonly used names, the Desert Range and the Silver Island Mountains, and that some clarification was necessary as to which name should be used. Considerable information was gathered regarding the use of both names, and this data was presented to the United States Board on Geographic Names of the Department of the Interior, Washington, D. C. A letter from the Board, dated June 13, 1956, contains the following: "The Board recommends use of the name Silver Island Mountains for the mountain range in Box Elder and Tooele Counties." The Board on Geographic Names made this decision final in their docket list number 13, dated December 10, 1959, which also included the naming of Campbell Peak, Cobb Peak, Jenkins Peak, Lamus Peak, Rishel Peak, and Tetzlaff Peak.

Stansbury (1853) was the first to use the term "island" for the isolated mountains or buttes in the salt desert. He observed, "The plain contained several island mountains, rising from it as from the water." One needs only to approach one of the "islands" after traveling across the seemingly endless salt desert to see how appropriate the use of the term island is.

Silver Island was so named because of the occurrence of native silver in its southern part. Silver Island is the largest segment of the range, hence the range is appropriately called the Silver Island Mountains. The naming of Crater Island will be discussed in the section "Historical Background."

Floating Island, the isolated butte east of Silver Island, was very appropriately named by builders of the Western Pacific Railroad who viewed the island from the distance and observed it to be apparently floating, the illusion being a desert mirage.

FIELD WORK

Field work was carried on by Anderson continuously from March through June and intermittently from July to September, 1956. Schaeffer carried on his field work during portions of 1956 through 1959.

Water was obtained from Wendover.

Stratigraphic sections were measured by using a tape and Brunton compass. Profiles used in making geologic cross sections were obtained from topographic maps (1:250,000) of the Army Map Service, Corps of Engineers.

Aerial photographs were flown by Jack Ammann, Photogrammetric Engineers in September, 1946 and August, 1950 at a scale of about 1:20,000. The geologic map prepared by Anderson (pl. 2A) was made by plotting geologic data on the aerial photographs and transferring the information to a base map prepared by the radial-line assembly method. The geologic maps prepared by Schaeffer (pls. 1A and 1B) were made by plotting geologic data on the aerial photographs and transferring the information by use of a "sketch master" to a base map prepared by the radial-line assembly method (modified by use of templates).

ALTERATIONS TO THE GEOLOGIC MAPS

The Dunderberg Shale as used by Anderson on the geologic map (pl. 2A) and stratigraphic section (fig. 16) of the Northern Silver Island Mountains is actually the upper part of the Weeks Formation. The Diamond Peak quartzite shown on Anderson's geologic map of the Northern Silver Island Mountains (pl. 2A) is probably the Strathearn Formation in some localities.

The area north of Lost Canyon on Silver Island (see pls. 1A and 2A) was beyond the area of radial-line control on plate 1A; therefore, the reader is referred to plate 2A for the details of this area.

ACKNOWLEDGEMENTS

The writers are especially grateful to Francis W. Christiansen of the Department of Geology, University of Utah, who suggested the geology of the Silver Island Mountains as a thesis problem, and who, as advisor, made many valuable suggestions concerning procedure and interpretation during the course of the studies.

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Identification of fossils by C. Lochman-Balk, Robert C. Bright, J. Thomas Dutro, Lehi Hintze, R. A. Robison, Walter Sadlick, Grant Steele, Dwight W. Taylor, R. H. Waite, and Ellis L. Yochelson is gratefully acknowledged. Walter P. Cottam, University of Utah Botany Department, idenitified the botanical specimens.

John K. Costain, Donald M. Blue, William Laraway, C. Bentley, R. A. Robison, Kaye Everett, and Dwayne D. Stone of the University of Utah and Brigham Young University assisted Schaeffer in measuring the stratigraph sections described in this guidebook.

Grant Steele of the Gulf Corporation, William Lee Stokes and Walter Sadlick gave the writers invaluable time for discussion of stratigraphic problems.

Bronson Stringham and Andrei Isotoff aided the writers in thin section identification of the igneous rocks in the area.

Dwayne D. Stone recorded dictation by Schaeffer in the preparation of the road log and made helpful suggestions.

The editor gratefully acknowledges the assistance received from Arthur L. Crawford and Staff, Utah Geological and Mineralogical Survey, John K. Costain, and Ralph J. Roberts.

The writers thank Paul M. Christensen of the Associated Flying "A" Service in Wendover for many kind courtesies, and Mr. and Mrs. Peter McKellar, owners of the McKellar Ranch at the base of Pilot Peak, for their fine hospitality and their help with historical and geographical data.

Financial assistance was provided by a University of Utah Graduate Reserch Fellowship and grants from the Mountain Fuel and Supply Company. Photographs for that part of the Silver Island Mountains which is situated in Nevada were loaned by the Gulf Oil Corp.

HISTORICAL BACKGROUND OF THE AREA

By

Warren L. Anderson

HASTINGS' CUTOFF

The Silver Island Mountains were first crossed by the Fremont Expedition in 1845 (see fig. 1), and it was Fremont who so appropriately named Pilot Peak (fig. 1) in the range about 11 miles to the west. A year afterward, the same route was followed by a party under the leadership of a Mr. Hastings. This route, from Salt Lake City across the salt desert, was substantially shorter for California-bound emigrants than the much-traveled Fort Hall route to the north, and consequently became known as "Hastings' Cutoff". However, people who used this cutoff soon learned that the attribute of shortness was far outweighed by the lack of adequate water and forage, resulting in unprecedented hardships to men and stock.

The Clyman-Hastings group passed over the route in May 1846, and they were followed in August of that year by the Bryant party and the Young-Harlan party. It is possible that some wagons were used by one or more of these parties. These early emigrant groups were followed by the Donner party (September 1846), whose over-loaded ox-drawn wagons, some of which were abandoned east of Floating Island, cut deep into the boggy underclay of the salt desert. A multitude of gold seekers, most of whom used horses and pack mules, followed in the Spring and Summer of 1850. The resulting trail is still clearly visible east of Silver Island and in Pilot Valley. This trail is a monument to the hardships and suffering endured by the travelers of Hastings' Cutoff.

After further exploration of the salt desert area, a new trail was discovered farther south via Granite Peak, where the distance between springs was much less. The Hastings' Cutoff trail had served its purpose, and after 1850 it was abandoned, never to be used again except by a few individuals who came to salvage what they could from wagons left by the Donner party and possibly others.

THE STANSBURY EXPEDITION

The Stansbury Expedition (1849) made the first complete reconnaissance of the Great Salt Lake. The expedition explored the area of the Silver Island Mountains in late October and early November of 1849, and although the exact trail cannot be seen, Stansbury's vivid description of their route is sufficient to plot it (see fig. 1).

Capt. Stansbury, who was a U. S. Army topographic engineer and not a geologist, was, nevertheless, sufficiently interested in the geology of the area to attempt to describe it. It is reasonable to assume that Crater Island, the northern "island" in the Silver Island Mountains, received its name from Stansbury's description (1853, p. 110) of its northern extremity. He observed what appeared to him to have been an ancient crater, "around which were sections of shales and sandstones, very much contorted, and dipping in opposite directions on opposite sides." Actually, it is an area where the intrusion of an igneous stock into sedimentary rock may have been a factor in causing the strata to dip in all directions.

STRATIGRAPHY OF THE SILVER ISLAND MOUNTAINS

By Frederick E. Schaeffer

Approximately 23,600 feet of miogeosynclinal strata representing every system of the Paleozoic are exposed in the Silver Island Mountains. The 23,600 feet of Paleozoic strata are divided among the various systems as follows: Cambrian, 7,700 feet; Ordovician, 5,000 feet; Silurian, 1,100 feet; Devonian, 4,000 feet; Mississippian, 1,400 feet; Pennsylvanian, 1,900 feet; and Permian, 2,500 feet.

No Precambrian or Mesozoic rocks outcrop.

Approximately 4,150 feet of lacustrine and volcanic strata representing the Tertiary System outcrop.

Quaternary deposits, predominantly fluvial and lacustrine, outcrop along the flanks of the range and form the surface exposures in the salt flats adjacent to the range.

Plates 1A, 1B, and 2A are the geologic maps of the Silver Islands Mountains which show the distribution of the various formations.

The measured sections are described under the descriptions of each formation in this section of the guidebook.

Plate 3 is a composite stratigraphic section of the Paleozoic formations in the Silver Island Mountains and will serve as a summary of the stratigraphy of the Silver Island Mountains.

Fossils are listed in the text and are numbered according to the corresponding rock unit numbers where collected in the measured section (see text and pl. 3).

Because the exact relative ages of the igneous rocks are not known, they are described in the sections on igneous rocks.

CAMBRIAN SYSTEM

The Cambrian System of the Silver Island Mountains is represented by 11 identifiable formations and possibly 2 additional formations which aggregate about 7,700 feet in thickness (see fig. 2).

At the suggestion of Grant Steele (1956, oral communication), the terminology for the Cambrian of the Silver Island Mountains follows that used by Wheeler (1948) in the House Range which lies 100 miles to the south.

Prospect Mountain Quartzite

History of nomenclature. — The Prospect Mountain Quartzite of Cambrian age was named by Hague (1883, p. 254) from exposures on Prospect Peak near Eureka, Nevada. It originally included 200 feet of beds now assigned to the Pioche Shale by Nolan and others (1956, p. 7).

Distribution. — The Prospect Mountain Quartzite is exposed only in the eastern portion of the Leppy Range east of Tetzlaff Peak (see pl. 1B).

Character and thickness. — In general, the Prospect Mountain Quartzite consists of medium-grained quartzite which is light gray to light green on fresh fracture and weathers dark orange brown to maroon (see pl. 3). However, quartz grains composing the beds range in grain size from fine to coarse and contain occasional lenses of poorly sorted, sub-rounded to rounded pebbles which have a maximum diameter of half an inch. Interbeds of light green shaly quartzite and siltstone, which are commonly micaceous, comprise about 2 percent of the section. The beds of quartzite average about 8 inches in thickness, but the interbeds of shaly quartzite and siltstone are thinner. Aqueous cross-bedding is common in the quartzite throughout the section.

The formation forms a cliff with a pronounced dip slope at its top caused by the relatively rapid erosion of the overlying Pioche Shale.

The base of the Prospect Mountain is not exposed in the Silver Island Mountains nor at the type locality in Eureka, Nevada. A total thickness of 1,403 feet was measured in the eastern portion of the Leppy Range as compared to 1,460 feet in the type locality (Nolan and others, 1956, p. 7).

Stratigraphic relations. — The Prospect Mountain is in fault contact with Upper Cambrian strata.

The overlying purple phyllites of the Pioche Shale lie conformably with marked lithologic and color contrast upon the dark orange-brown weathered quartzites of the Prospect Mountain.

Age and correlation. — The Prospect Mountain Quartzite is the oldest formation exposed in the Silver Island Mountains.

The oldest accurately dated fauna in the Cambrian sequence of the Silver Island Mountains was found in the Condor Formation, about 3,147 feet stratigraphically above the top of the Prospect Mountain. It represents the middle *Bathyuriscus-Elrathina* zone of Middle Cambrian age (Lochman-Balk, 1958, written communication). Thus, it is not definitely known whether the Prospect Mountain Quartzite is Early or Middle Cambrian in age. However, the Cabin Shale which overlies the Prospect Mountain Quartzite at Gold Hill, Utah, 50 miles to the south, is Early Cambrian in age (Nolan, 1935, p. 7). Bick (1959) has correlated the Cabin Shale with the Pioche Shale. Thus, the Prospect Mountain Quartzite in the Silver Island Mountains may be tentatively assigned to the Lower Cambrian.

The Prospect Mountain Quartzite is correlated with its type locality in Eureka, Nevada, based on lithology and stratigraphic position.

The Prospect Mountain and its lithologic equivalents — Tapeats, Tintic, Brigham, and Flathead quartzites — are widespread from Arizona to Montana.

Measured section. —

Section of the Prospect Mountain Quartzite in E½ Sec. 16, T. 1 N., R. 18 W.

Cambrian:

Pioche Shale.

Prospect Mountain Quartzite (incomplete):

Unit	*Description*	*Feet*
13.	Quartzite and siltstone, interbedded: quartzite, light-green to light-blue; weathers dark orange brown; (marble cake banding); coarse-grained and occasionaly fine-grained; beds 1 to 2 feet in thickness; cross-bedded and greeen siltstone; weathers brown green to red; micaceous, quartzitic; fissile to thin-bedded; siltstone decreases 160 feet above base, entire unit forms cliff	685
12.	Quartzite, light-gray to light-green; weathers medium to dark orange brown; fine-grained; vitreous; thick-bedded; cross-bedded; forms cliff	9
11.	Quartzite and siltstone, as unit 13 except without marble cake banding	84
10.	Quartzite, light-green to light-blue; weathers dark orange tan; coarse-grained predominates; medium-bedded; cross-bedded; forms cliff	93
9.	Quartzite, very light-gray; weathers orange brown to white; fine-grained; vitreous; medium-bedded; cross-bedded forms cliff	102
8.	Covered	79
7.	Quartzite, very light-gray, weathers white to brown; fine-grained; lenses of poorly sorted coarse-grained material; vitreous; medium-banded; cross-bedded; forms cliff	7
6.	Covered	32
5.	Quartzite, as unit 4 except with lenses of poorly sorted coarse-grained material	17
4.	Quartzite and siltstone, interbedded; quartzite, light-gray to light-pink; weathers orange brown to orange maroon; fine-grained to medium-grained, medium-grained predominates; thin- to medium-bedded; cross-bedded; and green siltstone weathers tannish green to red; quartzitic, micaceous; fissile to platy; forms cliff	159
3.	Quartzite, light-gray; weathers medium orange brown; fine-grained; medium bedded; cross-bedded	5
2.	Quartzite, light-gray to light-pink; weathers dark orange brown to orange maroon; medium to very coarse-grained, coarse-grained predominates, poorly sorted; medium-bedded; cross-bedded	7
1.	Quartzite, light-gray to light-pink; weathers dark to orange brown to maroon; fine-grained; medium-bedded; cross-bedded; forms cliff	124
	Total Prospect Mountain Quartzite	1,403

Base not exposed.

Pioche Shale

History of nomenclature. — The Pioche Shale of Cambrian age was first described by Walcott (1908, p. 11) near Pioche, Nevada.

Distribution. — The Pioche Shale is exposed in the eastern portion of the Leppy Range northeast of Tetzlaff Peak (see pl. 1B).

Character and thickness. — The characteristic rock types of the Pioche Shale are purple and black phyllites with interbeds of brown siltstone (see pl. 3). The phyllites are fissile to platy; whereas, the siltstones are platy. Cubes of hematite pseudomorphous after pyrite are common.

The formation forms a slope and is protected by the overlying resistant Busby Quartzite.

A total thickness of 285 feet of Pioche Shale was measured in the Silver Island Mountains as compared to 1,120 feet at its type locality in Pioche, Nevada (Westgate and Knopf, 1932, p. 9).

Stratigraphic relations. — The Pioche Shale rests conformably on the Prospect Mountain Quartzite and is overlain concordantly by the Busby Quartzite. Both contacts are sharp with quartzites underlying and overlying the phyllites of the Pioche Shale.

Paleontology. — Except for *Protospongia,* which is common, no fossils have been found.

Age and correlation. — The Pioche Shale is assigned an Early Cambrian age as it is correlative with the Cabin Shale of Gold Hill, Utah, (Bick, 1959, p. 1066) which is dated as Early Cambrian (Nolan, 1935, p.7).

The Pioche Shale is correlated with its type locality at Pioche, Nevada, on the basis of lithology and stratigraphic position. Limestone units such as occur in the type locality are not present in the Silver Island Mountains.

The Pioche Shale and its lithologic equivalents are widespread in western Utah and eastern Nevada as noted by Wheeler and Steele (1951, p. 34) and Cohenour (1957, p. 43).

Measured section. —

Section of the Pioche Shale
in N½ sec. 9, T. 1 N., R. 18 W.

Cambrian:

Busby Quartzite.

Pioche Shale:

Unit	*Description*	*Feet*
3.	Phylilte, light reddish-purple; weathers medium to dark purple and black; fissile; forms slope	107
2.	Phyllite and siltstone, interbedded: phyllite, black; fissile; and light orange-brown siltstone; weathers dark orange brown; platy; cubes of hematite; forms slope; fossils — *Protospongia*	107
1.	Phyllite, back to medium-purple; weathers medium purple; platy; 1-inch cubes of hematite; ferruginous staining along partings; forms slope; fossils — *Protospongia*	71
	Total Pioche Shale	285

Prospect Mountain Quartzite.

Busby Quartzite

History of nomenclature. — The Busby Quartzite of Cambrian age was described by Nolan (1935, p. 8) from Busby Canyon on the east slope of Dutch Mountain, Gold Hill, Utah.

Distribution. — The Busby Quartzite is exposed in the eastern portion of the Leppy Range northeast of Tetzlaff Peak (see pl. 1B).

Character and thickness. — Thin-bedded, medium to coarse-grained, brown quartzites are characteristic of the Busby Quartzite (see pl. 3). The lower portion of the formation forms a ledge; whereas, the upper portion forms a slope.

It was impossible to obtain the true thickness of the Busby in the Silver Island Mountains because of poor exposures. However, a minimum thickness of 142 feet and a maximum thickness of 572 feet were measured. At Gold Hill, Utah, Nolan (1935, p. 8) measured 452 feet of the formation.

Stratigraphic relations. — The brown quartzites of the Busby Quartzite rests concordantly and with marked contrast upon the purple phyllites of the Pioche Shale. The brown quartzites of the Busby Quartzite are conformably and with marked contrast overlain by the bronze colored to dark-gray limestones of the Millard Limestone.

Age and correlation. — In the Silver Island Moutnains the Busby Quartzite has yielded no fossils. However, specimens collected by Cohenour (1957, p. 46) from the Busby Quartzite of the Sheeprock Mountains, Utah, and identified by R. C. Bright are assigned an early Albertella age; and therefore, the Busby in the Silver Island Mountains is tentatively assigned an early Middle Cambrian age.

The Busby Quartzite is correlated with its type locality at Gold Hill, Utah, on the basis of lithology and stratigraphic position.

The Busby Quartzite is widespread in eastern Nevada and western Utah according to Wheeler and Steele (1951, p. 34) and Cohenour (1957, p. 47).

Measured section. —

Section of the Busby Quartzite
in NE¼ sec. 9, T. 1 N., R. 18 W.

Cambrian:

Millard Limestone.

Busby Quartzite (faulted?):

5.	Quartzite, light-gray to medium-tan; weathers light to dark brown; fine-grained; calcareous; thin- to medium-bedded; forms slope	65
4.	Covered, probably quartzite as unit 5; possible fault	231?
3.	Quartzite, medium-gray; weathers very dark brown; medium- to coarse-grained; calcareous; thin- to medium-bedded; forms slope	15
2.	Quartzite, light-gray to medium-brown; weathers very dark brown (occasionally wethers medium gray to medium yellow green brown); medium to coarse-grained; thin- to thick-bedded; forms slope	172
1.	Quartzite, purple, weathers dark to medium brown (occasionally weathers light greenish tan); fine- to coarse-grained (medium-grained predominates); thin-bedded; forms slope	89
	Total Busby Quartzite	572?

Pioche Shale.

Millard Limestone, Burrows Limestone?, and Burnt Canyon Limestone? Undifferentiated

History of nomenclature. — The Millard Limestone of Cambrian age was named by Wheeler (1948, p. 35) for the dark-gray, fine- to medium-grained, limestones that make up the basal 281 feet of the Howell Limestone as emended by Deiss (1938, p. 1144) in the House Range, Utah.

The Burrows Limestone was first defined by Wheeler (1940) as the "dolomite" of the Pioche district that lies between the Peasley Limestone and the basal unit of the restricted Highland Peak Limestone. Later observations by Wheeler (1948, p. 56) in the House Range, Utah, indicated that the Burrows is a thick- to massive-bedded, light-colored limestone which has locally been subjected to epigenetic dolomitization. In the House Range, Wheeler (1948, p. 36) described the Burrows as the light-gray zone, 340 feet in thickness in the middle portion of the Howell Limestone as emended by Deiss (1938, p. 1145).

The Burnt Canyon Limestone was described by Wheeler (1948, p. 37) from exposures in the Highland Range, Pioche district, Nevada. Wheeler (1948, p. 38) correlated the Burnt Canyon with the uppermost 225 feet of the Howell Limestone as emended by Deiss (1938, p. 1145) in the House Range, Utah.

Distribution. — The Millard, Burrows?, and Burnt Canyon? Limestones undifferentiated are exposed in the eastern portion of the Leppy Range on the north slope of Millard Canyon and to the southeast of Jenkins Peak in Silver Island (see p. 1A and 1B).

Character and thickness. — The measured section of undifferentiated limestones is divided into two members (see pl. 3). The lower member consists of fissile to platy, argillaceous, fine-crystalline, bronze weathering, dark-gray on fresh fracture, limestone which forms slopes and ledges. The upper member consists of thin- to thick-bedded, argillaceous, fine-crystalline, bronze weathering, dark-gray on fresh fracture, limestone which forms cliffs and slopes.

The lower member is 612 feet in thickness; whereas, the upper member is about 1,167 feet in thickness. The Millard, Burrows?, and Burnt Canyon? Limestones undifferentiated aggregate 1,779 feet in thickness in the Silver Island Mountains as compared to 815 feet in the House Range, Utah (Wheeler and Steele, 1951, p. 32).

Stratigraphic relations. — The bronze weathering Millard Limestone concordantly overlies the brown Busby Quartzite. The Millard, Burrows?, and Burnt Canyon? Limestones undifferentiated are conformably overlain by the Dome Formation?. The upper contract is placed at the top of a sequence of argillaceous limestones and at the base of a sequence of dolomites. The dolomites aggregate about 300 feet in thickness. There is a fault of unknown displacement 1,504 feet above the base of the Millard, Burrows?, and Burnt Canyon? Limestones undifferentiated.

Paleontology. — One trilobite too poorly preserved for identification was collected from the lower unit of the undifferentiated limestones.

Age and correlation. — The Millard, Burrows?, and Burnt Canyon? Limestones undifferentiated in the Silver Island Mountains are correlated with the Millard, Burrows, and Burnt Canyon Limestones of Middle Cambrian age in the House Range, Utah, as described by Wheeler (1948), based on stratigraphic position. A much better lithologic correlation for the undifferentiated limestones would be with the lower portion of the Abercrombie Formation of Gold Hill (Nolan, 1935, p. 8). According to Wheeler (1948, figure 5), the Abercrombie Formation is stratigraphically equivalent to Millard Limestone, Burrows Limestone, Burnt Canyon Limestone, Dome Limestone, Conder Formation, Swasey Limestone (restricted), Wheeler Shale, and Marjum Limestone. However, five formations stratigraphically equivalent to the middle and upper portions of the Abercrombie Formation have been mapped separately in the Silver Island Mountains; and therefore, it is not feasible to use Abercrombie terminology in the Silver Island Mountains.

The lower member of the undifferentiated limestones in the Silver Island Mountains is similar in lithology to the Chisholm Shale as described by Westgate and Knopf (1932, p. 11). However, the Chisholm Shale is only 180 feet thick; whereas, the lower member of the undifferentiated limestones is 612 feet thick. The lower member in the Silver Island Mountains may be stratigraphically equivalent to the combined Lyndon, Chisholm, and Peaseley formations of the Pioche district, Nevada. These formations have been correlated by Wheeler (1948, figure 5) as stratigraphically equivalent to the Millard Limestone, and they aggregate about 700 feet in thickness

(Wheeler, 1940, p. 12). Thus the lower member of the undifferentiated limestones is thought by the writer to be stratigraphically equivalent to the Millard Limestone.

The upper member of the undifferentiated limestones is thought by the writer to be stratigraphically equivalent to the Burnt Canyon Limestone of th House Range based on lithology. However, the upper member may be in part stratigraphically equivalent to the Burrows Formation; therefore, the upper member is tentatively correlated with the Burrows and Burnt Canyon Limestones of the House Range based on stratigraphic position.

Measured section. —

Section of the Millard Limestone, Burrows Limestone?, and Burnt Canyon Limestone? Undifferentiated in in SE1/4 sec. 5, T. 1 N., R. 18 W. and NE1/4NE1/4 sec. 29, T. 2 N., R. 17 W., (unsurveyed).

Cambrian:

Dome Formation?

Millard Limestone, Burrows Limestone?, and Burnt Canyon Limestone? undifferentiated (faulted):

Upper member (faulted):

Unit	*Description*	*Feet*
22.	Covered; forms slope	12
21.	Limestone, white; very fine-crystalilne; recrystalilzed; argillaceous seams; extremely shaly	11
20.	Limestone, medium-gray; weathers orange to gray; very fine-crystalline; argillaceous; very oölitic; splashes of iron coating	36
19.	Dolomite, light-gray; weathers light tan to light gray, very fine-crystalline; calcareous	40
18.	Dolomite, dark-gray; weathers black; very fine-crystalline; tan mottling	10
17.	Dolomite, medium-gray; weathers light-tan; very fine-crystalline	3
16.	Limestone, medium to dark-gray; weathers orange to gray; very fine-crystalline; argillaceous; thin-bedded; unduating bedding planes; argillaceous material adds a brown and orange color to the unit; middle portion of unit is very oölitic	79
15.	Limestone, light-gray to tan-gray; weathers tan, orange, and buff; very fine-crystalline, argillaceous; silicified lenses; stringers of iron coating; forms slope	50
14.	Limestone, light-gray; weathers orange-tan; very fine-crystalline; dolomitic	14
13.	Limestone, as unit 15	20
12.	Limestone, dark-gray; weathers bronze; fine-crystalline; argillaceous seams; thick-bedded, occasionally platy; cross-bedded; small pyrite crystals very common; forms slope	185
11.	Limestone, dark-gray; weathers medium gray to light orange; fine-crystalline; argillaceous; thin- to medium-bedded; forms slope	233
10.	Limestone, dark-gray; weathers medium to dark gray; fine-crystalline; small amounts of argillaceous material, thin- to thick bedded; undulating bedding planes in upper portion; forms slope	47
9.	Limestone, as unit 12 but forms cliff	427
	Total Upper member	1,167?

Lower member

Unit	*Description*	*Feet*
8.	Limestone, black; weathers dark gray; 1/4- to 1/2-inch orange argillaceous intervals alternate with 1- to 2-inch non-argillaceous intervals; forms ledges	24
7.	Limestone, black; weathers dark gray; 1- to 2-inch orange argillaceous intervals alternate with 2- to 4-inch non-argillaceous intervals; fissile to platy; forms ledges	27
6.	Limestone, as unit 7, but less fissile	205
5.	Limestone, dark-gray to black; weathers dark gray to black and bronze; fine-crystalline; fissile to platy; platy beds are argillaceous; occasional maroon mottling; hematite cubes forms slope	22
4.	Limestone, as unit 6	36
3.	Limestone, as unit 5	64
2.	Slate and limestone, interbedded; dark gray; very fine crystalline; fissile; occasional maroon and light green mottling; forms slope	74
1.	Limestone, dark gray; weathers medium orange to bronze; fine-crystalline micaceous, argillaceous; fissile to platy; forms slope	160
	Total Lower Member	612
	Total Millard Limestone, Burrows Limestone?, and Burnt Canyon Limestone? undifferentiated	1,779

Busby Quartzite.

Dome Formation?

History of nomenclature. — The Dome Limestone was defined by Walcott (1908a, p. 11) as a massive-bedded, gray, siliceous limestone. Its type locality is at the head of Dome Canyon in the House Range, Utah. The emended section of the Dome (Deiss, 1938, p. 1145) was measured on the north side of Marjum Canyon, House Range, Utah. In regard to this exposure Deiss (1938, p. 1145) states:

> "The formation is 310 feet thick, and consists of black- and dark-gray, thick- and thin-bedded, fine-grained limestone, which contains drab-tan and maroon clay flakes, laminae, and nodules in the lower two-thirds, and dull-gray argillaceous pure limestone in the upper third. The Dome limestone forms sheer gray cliffs wherever exposed in the House Range . . . and appears to be unfossiliferous."

The Dome is referred to as a formation in the Silver Island Mountains because of its heterogeneous lithology.

Distribution. — The Dome Formation? is exposed in Silver Island immediately southeast of Jenkins Peak (see pl. 1A).

Character and thickness. — The Dome Formation? aggregates 355 feet in thickness (see pl. 3). The upper 47 feet of the formation is a steep slope-forming, recrystallized, fine-crystalline, white limestone which contains seams of argillaceous material. The remainder of the formation consists of steep slope-forming; calcareous; very fine- to very coarse-crystalline; white, gray, and black dolomite which contains vugs filled with the mineral dolomite. The Dome? is occasionally mottled orange.

Stratigraphic relations. — The conformable contact between the Dome Formation? and the underlying Burnt Canyon Limestone? is placed at the base of a dolomite sequence which is about 300 feet in thickness.

The conformable contact between the Dome Formation and the overlying Condor Formation is drawn at the top of a recrystallized, white limestone which contains seams of argillaceous material and at the base of a dolomitic, dark-gray to black limestone which is iron stained and weithers orange brown.

Paleontology. — The Dome Formation? has yielded no fossils in the Silver Island Mountains.

Age and correlation. — The Dome Formation? has yielded no fossils at its type locality (Wheeler, 1948, p. 39). With regard to the age of the Dome, Wheeler (1948, p. 39) states.

> "However, its position between the *Glossopleura-Kootentia* fauna of the overlying Condor member of the Swasey limestone suggests is that in the House Range, at least, it probably lies within both zones."

The Dome Formation is assigned to the Middle Cambrian (Deiss, 1938, p. 1145) and (Wheeler, 1948, Fig. 5).

In the Silver Island Mountains, the Dome Formation? is tentatively assigned a Middle Cambrian age based on the correlation below.

The Dome Formation? is tentatively correlated with its type locality in the House Range, Utah, as emended by Deiss (1938, p. 1145) based on stratigraphic position.

Measured section.

Section of the Dome Formation in NE¼ sec. 29, T. 2 N., R. 17 W. (unsurveyed)

Cambrian:

Condor Formation.

Dome Formation?:

Unit	*Description*	*Feet*
5.	Limestone, white; fine-crystalline; recrystallized; argillaceous seams; undulating bedding palnes; forms slope	47
4.	Dolomite, white to light-gray; weathers medium tan; very fine- to very coarse-crystalline; 10 feet above the base is a 1-foot bed of dark-gray to black dolomite, forms steep slope	192
3.	Dolomite, black; weathers dark gray; very-fine crystalline, ferruginous staining; orange mottling; vugs filled with dolomite	106
2.	Dolomite, dark gray to black; weathers black; very fine-crystalline; calcareous	3
1.	Dolomite, medium to dark-gray; weathers medium tan gray; very fine-crystalline, calcareous massive	7
	Total Dome Formation?	355

Burnt Canyon Limestone

Condor Formation and Restricted Swasey Limestone

History of nomenclature. — Walcott (1908a, p. 11) originally defined the Swasey Formation from the slopes of Swasey Peak in the House Range, Utah. The formation was emended by Deiss (1938, p. 1145) and assigned a new type locality in Marjum Canyon, House Range, Utah.

Wheeler (1948, p. 39) reports that the Swasey Limestone consists of 395 feet of strata which are divisible into two parts: the basal 117 feet "consists largely of thinly inter-bedded calcareous, argillaceous, and arenaceous strata" (Wheeler, 1948, p. 39); the upper 278 feet "consists of dark- and black-gray, medium grained, massive and irregular bedded limestone" (Deiss, 1938, p. 1146). The basal 117 feet is designated by Wheeler (1948, p. 39) as the Condor member. Steele (1956, oral communication) has stated that the Condor member should be elevated to formational status, and Cohenour (1957, p. 57) has proposed that the Condor member be elevated to formational status as it is sufficiently widespread and distinct to qualify as a formation. This would, of necessity, restrict the Swasey Limestone to the upper part of the Swasey Limestone of previous writers (Cohenour, 1957, p. 60).

Distribution. — The Condor Formation and restricted Swasey Limestone are exposed southeast of Jenkins Peak in Silver Island (see pl. 1A).

Character and thickness. — The Condor Formation aggregates 265 feet in thickness in Silver Island. Generally, it consists of dolomitic, very fine- to medium-crystalline, medium-gray to black and tan limestone which weathers orange-tan, cream-gray, tan, gray, and black. The Condor Formation contains numerous brown iron coated layers, and orange mottling is common (see pl. 3).

The restricted Swasey Limestone aggregates 307 feet in thickness in Silver Island. It consists of very fine-crystalline, medium- to dark-gray and white to tan limestone which is mottled orange-brown (see pl. 3).

The two formations form a cliff.

In the Silver Island Mountains, the combined thickness of the Condor Formation and the restricted Swasey Limestone ranges from 572 feet in Silver Island to 406 feet in Crater Island (Anderson, 1957, p. 22).

Stratigraphic relations. — The conformable contact between the Condor Formation and the underlying Dome Formation? is placed at the top of a recrystallized, fine-crystalline, white limestone which contains seams of argillaceous material and at the base of a dolomitic, very fine-crystalline, black limestone which weathers orange tan and has iron coated bands.

The conformable contact between the Condor Formation and the overlying restricted Swasey Limestone is placed at the top of a medium-crystalline, white to tan limestone which weathers light tan and contains numerous brown iron coated layers which are ½-inch to 2 feet in thickness; and at the base of a very fine-crystalline, medium-gray limestone which is mottled light orange. This contact is gradational.

The conformable contact between the restricted Swasey Limestone and the overlying Wheeler Shale is placed at the top of a massive, very fine-crystalline, medium to dark-gray limestone which is mottled orange brown; and at the base of a slope-forming, shaly, argillaceous, fine- to medium-crystalline, dark-gray to black limestone which has iron coated bands.

Paleontology. — Unit 8 of the Condor Formation yielded the following fauna which was identified by Lochman-Balk (1958, written communication).

Ehmaniella cf. *burgessensis* Rosetti "cf. new genus — is either new or the preservation is deceptive so it looks like nothing I have seen at this position."

Elrathina cf. *E. parallela* Rosetti

"This assemblage is also in the *Bathyuriscus-Elrathina* zone, but lower than your collections from the Wheeler shale. It would seem to be about the age of Rosetti's faunules 5 and 6 in the British Columbia sections which seem to be about the middle of the *Bathyuriscus-Elrathina* zone."

Age and correlation. — The formations are assigned a Middle Cambrian age on faunal evidence.

The Condor Formation and restricted Swasey Limestone are correlated with their type locality in the House Range, Utah, based on lithology, stratigraphic position and fauna.

Measured section. —

Section of the Restricted Swasey Limestone in NW1/4NE1/4 sec. 29, T. 2 N., R. 17 W. (unsurveyed)

Cambrian:

Wheeler Shale.

Restricted Swasey Limestone:

Unit	*Description*	*Feet*
7.	Limestone, medium- to dark-gray; weathers medium to dark gray in basal 30 feet and is mottled orange-brown; the succeeding 24 feet has a pronounced banded appearance due to occasional 1- to 3-foot bands of white limestone which occur in an interval of predominantly medium- to dark-gray weathering limestones; the following 12 feet weathers brown; the following 158 feet weathers light to medium gray; the upper 20 feet weathers white; the entire unit is very fine-crystalline; forms cliff	244
6.	Limestone, white to tan; very fine-crystalline	7
5.	Limestone, medium-gray; weathers light to medium gray; very fine-crystalline, slight orange mottling	2
4.	Limestone, as unit 6 except with iron coated bands	8
3.	Limestone, as unit 5	3
2.	Limestone, as unit 6	4
1.	Limestone, as unit 5	39
	Total Restricted Swasey Limestone	307

Condor Formation.

Section of the Condor Formation in NW1/4NE1/4 sec. 29, T. 2 N., R. 17 W., (unsurveyed)

Cambrian:

Restricted Swasey Limestone.

Condor Formation:

Unit	*Description*	*Feet*
10.	Limestone, white to tan; weathers light tan; medium-crystalline; extreme iron coated layers 1/2-inch to 3 feet in thickness; upper contact gradational	28
9.	Covered, forms slope	17
8.	Limestone, dark-gray to black; weathers dark gray to black; very fine-crystalline; iron coated bands; orange mottling; spangled; forms cilff; fossils — *Ehmaniella* cf. *burgessensis, Elrathina* cf. *E. parallela*	64
7.	Covered unit, forms slope	36
6.	Limestone, medium-gray to black; weathers tan, gray, and black medium-crystalline; dolomitic; occasional vugs filled with mineral dolomite spangled	20
5.	Dolomite, tan-gray; weathers medium tan; very fine-crystalline; calcareous; vugs filled with mineral dolomite	46
4.	Dolomite, medium-gray; weathers tan gray; very fine-crystalline; calcareous; vugs filled with mineral dolomite	5
3.	Limestone, dark-gray; weathers cream gray; very fine-crystalline; dolomitic; red to orange mottling	8
2.	Limestone, dark-gray; fine-crystalline; argillaceous; orange mottling; iron coated bands; forms slope	38
1.	Limestone, dark to black; weathers orange tan; very fine-crystalline; dolomitic; upper 2 inches is iron coated; spangled	3
	Total Condor Formation	265

Dome Formation?

Wheeler Shale

History of nomenclature. — Walcott (1908a) originally defined the Wheeler Shale in the House Range, Utah. The formation was later emended by Deiss (1938, p. 1146) who states that at the type locality the Wheeler "consists of dull sooty black, fine-grained, hard, platy and, rarely, fissile, calcareous shale, which weathers pale-gray and contains numerous intercalated argillaceous and finely arenaceous platy limestones which increase slightly upward."

Distribution. — The Wheeler Shale is exposed immediately southeast of Jenkins Peak in Silver Island (see pl. 1A).

Character and thickness. — The Wheeler Shale aggregates 280 feet in thickness in Silver Island. It consists of slope- to ledge-forming, fine- to medium-crystalline, dark-gray to black limestone; orange to brown mudstone; slope-forming, platy to thin-bedded, calcareous, black, orange-brown argillite; and slope-forming fissile to platy, black slate (see pl. 3).

In the Silver Island Mountains, the Wheeler Shale ranges in thickness from 280 feet in Silver Island to 32 feet in Crater Island (Anderson, 1957, p. 22).

In northern Crater Island, the interval of the Wheeler Shale is represented by a sandstone (Anderson, 1957, p. 22).

Stratigraphic relations. — The conformable contact between the Wheeler Shale and the underlying restricted Swasey Limestone is placed at the top of a cliff-forming, very fine-crystalline, medium- to dark-gray limestone which is mottled orange-brown; and at the base of a slope-forming, shaly, argillaceous, fine to medium-crysalline, dark-gray to black limestone which has iron coated bands.

The conformable gradational contact between the Wheeler Shale and the overlying Marjum Limestone is arbitrarily placed at the top of a slope and at the base of a cliff in a sequence of fine-crystalline, dark gray limestone beds interbedded with orange to brown mudstone beds.

Paleontology. — Lochman-Balk (1958, written communication) identified the following fauna from the Wheeler Shale.

Unit 1 — *Acrotreta* sp.
agnostid cf. *Peronopsis columbiensis*
Asaphiscus wheeleri
cf. *Ehmaniella* sp.

"The horizon is the *Bathyuriscus-Elrathina* zone of Rosetti and the assemblage here and in unit 3, both of which are characterized by *Asaphiscus wheeleri,* appear to belong near the very top of this faunal zone as we are now using it. These assembliges are higher than anything recorded by Rosetti from British Columbia."

Unit 3 — *Asaphiscus wheeleri*
cf.*Glyphaspis* sp. cranidium
cf. *Elrathina or Ehmaniella* sp.

Lochman-Balk (1958, written communication) states the following with regard to the fauna collected by the writer in the upper part of the Wheeler Shale.

"This material contains specimens of a genus at present referred to *"Glyphasis"* in quotes because it seems similar but not identical to species of this genus which occur lower. Many of the specimmens including the ones with the thorax seem to belong to a new genus which seems most similar to the form identified as *"Perioura"*, but it does not fit that genus well enough to refer the specimens to it. One poorly preserved cranidium suggests *Asaphiscus laeviceps* and a few other pygidia may be referred to *Modocia.* The horizon is in the lower part of the unnamed faunal zone which lies at the top of the Middle Cambrian."

R. C. Bright identified *Paterina* sp. ? from unit 1 of the Wheeler Shale.

Age and correlation. — The Wheeler Shale in Silver Island is assigned a Middle Cambrian age based on faunal evidence. It is correlated with its type locality in the House Range, Utah, based on lithology, stratigraphic position and fauna.

Measured section. —

Section of the Wheeler Shale
in SW1/4SE1/4 sec. 20, T. 2 N., R. 17 W. (unsurveyed)

Cambrian:

Marjum Limestone.

Wheeler Shale:

Unit	*Description*	*Feet*
4.	Limestone, dark-gray; fine-crystalline; and orange to brown mudstone; interbedded; limestone and mudstone beds are 1 inch in thickness; forms cliff	32
3.	Argillite, black; weathers rust brown to dark gray; calcareous; fissile to platy; and fissile, black slate; interbedded; forms steep slope; fossils — *Asaphiscus wheeleri,* cf. *Glyphaspis* sp., cf. *Elrathina* or *Ehmaniella*	125
2.	Argillite, orange-brown; fissile, black slate; and dark-gray limestone; interbedded; forms ledges	77
1.	Limestone, dark-gray to black; weathers dark gray; fine- to medium-crystalline; orange to brown argillaceous material along partings; iron coated bands; platy; forms slope, fossils — *Acrotreta* sp., agnostid cf. *Peronopsis columbiensis, Asaphiscus wheeleri Elrathia* cf. *kingi,* cf. *Ehmaniella*	46
	Total Wheeler Shale	280

Restricted Swasey Limestone.

Marjum Limestone

History of nomenclature. — Walcott (1908a) originally defined the Marjum Limestone of Cambrian age in the House Range, Utah. Deiss (1938, p. 1147) emended this definition and described the lithology of the Marjum Limestone as follows:

"The lower 102 feet of the Marjum are black-, blue-, and dull-gray, fine- to medium grained, fossiliferous limestones which contain buff and orange-tan clay flakes. The limestone weathers gray and forms a steeper slope above the Wheeler shale. Overlying the basal limestone is a zone, 878 feet thick which consists of alternate intervals of — shale, lithologically similar to that in the Wheeler, interbedded with varying thicknesses of dark- and light-gray fossiliferous limestone."

The upper 450 feet of the Marjum is similar to that of the lower 102 feet.

Distribution. — The Marjum Limestone is exposed immediately southeast of Jenkins Peak in Silver Island (see pl. 1A).

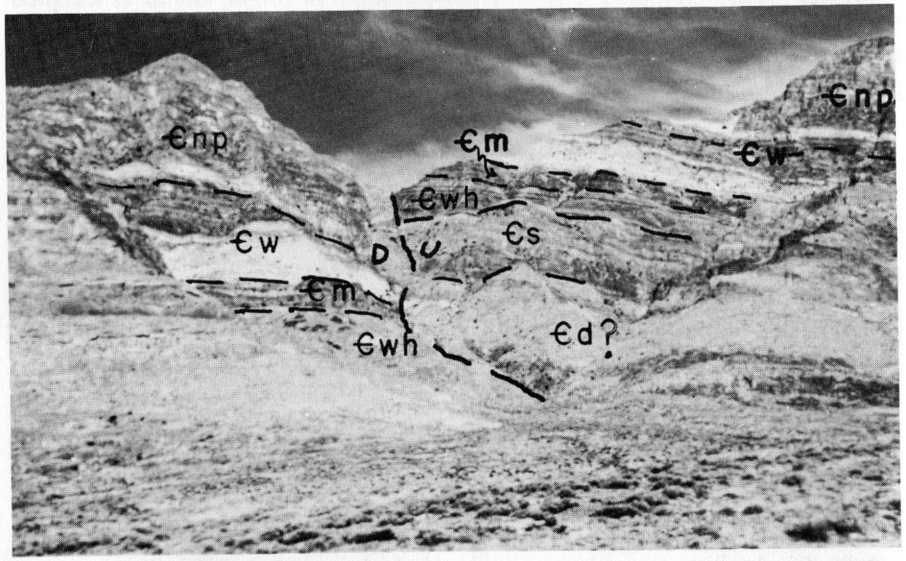


Fig. 2. View looking west, Lamus Peak on left. Єd, Dome Formation; Єs, Condor Formation and Swasey Limestone (restricted) undifferentiated; Єwh, Wheeler Shale; Єm, Marjum Limestone; Єw, Weeks Formation; Єnp, Notch Peak Formation.

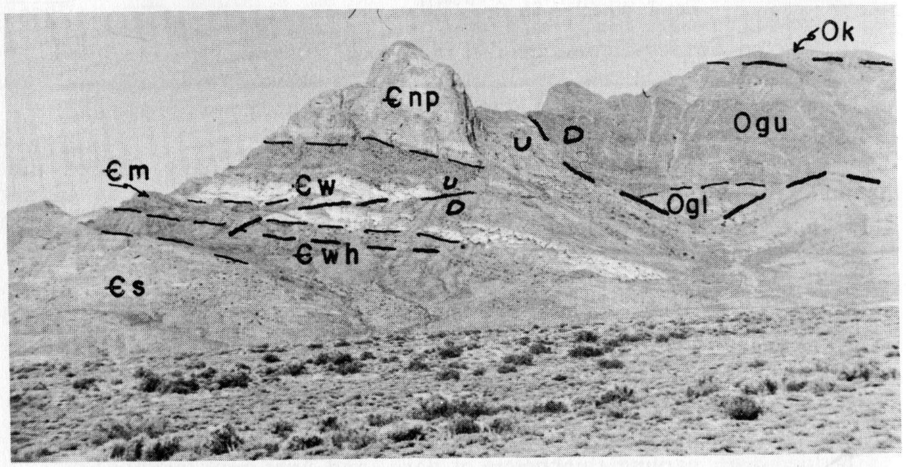


Fig. 3. View looking west, Jenkins Peak on right. Єs, Condor Formation and Swasey Limestone (restricted) undifferentiated; Єwh, Wheeler Shale; Єm, Marjum Limestone; Єw, Weeks Formation; Єnp, Notch Peak Formation; Ogl, Lower member of Garden City Formation; Ogu, Upper Cherty member of Garden City Formation; Ok, Kanosh Shale.

Character and thickness. — The Marjum Limestone in Silver Island consists of a massive, very fine- to medium-crystalline, dark-gray limestone; and orange-brown mudstone. The limestone is mottled with light gray blotches. An occasional bed of intraformational conglomerate was also noted.

In the Silver Island Mountains, the Marjum Limestone ranges in thickness from 290 feet in Silver Island to 111 feet in Crater Island (Anderson, 1957, p. 23).

Stratigraphic relations. — The conformable, gradational contact between the cliff-forming Marjum Limestone and the underlying slope-forming Wheeler Shale is arbitrarily placed at the topographic break between the two formations in a sequence of interbedded fine-crystalline, dark-gray limestone and orange to brown mudstone.

The sharp, conformable contact between the Marjum Limestone and the overlying Weeks Formation is placed at the top of a sequence of dark-gray limestone interbedded with orange to brown mudstone and at the base of a bed of medium- to very coarse-crystalline, light-gray dolomite.

Paleontology. — Lochman-Balk (1958, written communication) states the following with regard to a specimen from the Marjum Limestone.

> "This single cranidium is squeezed as usual but does appear to have a boss on the preglabellar field — this strongly suggests that it is the genus *Bolaspis* — which is characteristic of the Unnamed faunal zone at the top of the Middle Cambrian."

Age and correlation. — The Marjum Limestone is assigned a late Middle Cambrian age by faunal evidence.

The formation is correlated with its type locality based on lithology, stratigraphic position, and fauna.

Measured section. —

Section of the Marjum Limestone
in SW1/4 SE1/4 sec. 20, T. 2 N., R. 17 W. (unsurveyed)

Cambrian:
Weeks Formation.
Marjum Limestone:

Unit	*Description*	*Feet*
2.	Limestone, dark-gray, weathers medium to dark gray; very fine- to medium crystalline; iron coated layers; light gray mottling in upper portion; and anastomosing orange to brown mudstone in basal 25 feet; interbedded; limestone and mudstone beds range in thickness from 1 to 2 inches in basal 2 feet; massive; forms cliff	128
1.	Limestone dark-gray; fine-crystalline; light gray mottling; and orange to brown mudstone; interbedded; 1-foot of intraformational congolmerate at top of unit; massive; forms slope for basal 30 feet and forms cliff for remainder of unit	162
	Total Marjum Limestone	290

Wheeler Shale.

Weeks Formation

History of nomenclature. — Walcott (1908a, p. 9-10) defined the Weeks Limestone in the House Range, Utah, as the thin-bedded, shaly limestones between the Marjum and Orr Formations.

Distribution. — The Weeks is well exposed in Silver Island to the south and east of Jenkins Peak and an incomplete section is exposed in the eastern portion of the Leppy Range, south of Tetzlaff Peak (see pls. 1A and 1B).

Character and thickness. — South and east of Jenkins Peak the lower half of the formation consists of medium- to very coarse-crystalline, light-gray dolomite which weathers light olive gray; and a recrystallized, white limestone which contains seams of argillaceous material. The recrystallized, white limestone (note white band in fig. 3) can be seen from the Cedar Mountains, Utah, a distance of approximately 55 miles.

The remainder of the formation consists of thin- to medium-bedded argillaceous, fine-crystalline, medium bluish- gray limestone which weathers olive gray to medium gray and contains scattered chert nodules. There is a 4-foot fissile, tan mudstone and siltstone unit at the base of this portion of the formation (see pl. 3).

Stratigraphic relations. — The conformable contact between the Weeks Formation and the underlying Marjum Limestone is drawn at the base of the first bed of medium- to very coarse-crystalline, light-gray dolomite.

The unconformable contact between the Weeks Formation and the overlying Notch Peak Formation is drawn at the top of the slope-forming limestones of the Weeks and at the base of the cliff-forming limestones of the Notch Peak.

The paraconformity between the Weeks Formation and the overlying Notch Peak Formation has been described by Lochman-Balk and Wilson (1958) as follows:

> "The boundaries of the *Aphelaspis* and *Elvinia* faunizones in the North American cratonic sites are defined by almost complete faunal changes. The changes are believed caused by the relatively rapid and mandatory responses made by the shelf biotas to pronounced environmental changes in the area. These environmental changes coincided with widespread emergence and shallowing of the seas over the North American cratonic and miogeosynclinal areas which reached a climax during Dunderbergia zone time."

Paleontology. — The following fauna was collected by the writer from the Weeks Formation and identified by Lochman-Balk (1958, written communication).

Lonchocephalus cf. *plena*
Genevievella sp.

Tricrepicephalus — two species
Blountia sp.

> "The horizon is in the lower half of the *Crepicephalus* zone of the Dresbachian stage. This fauna you sent me correlates with the *Crepicephalus* zone of the Weeks Formation."

R. C. Bright (1958, oral communication) identified the following additional fauna from the Weeks Formation.

Acrotreta sp.
Linguloid brachiopod
obolloid brachiopod
Pseudoagnostus sp.

Bright assigned a late Cambrian age to this fauna.

Age and correlation. — The Weeks Formation in the Silver Island Mountains is assigned to the Dresbachian stage of the Upper Cambrian by faunal evidence.

Wheeler (1948, p. 41) states:

> "The uppermost fauna of the 'Weeks' is represented by *Tricrepicephalus* which is characteristic of the *Crepicephalus* zone of the Upper Cambrian, although this 'Formation' is shown by Howell *et al.* (1944) as extending into the *Aphelaspis* zone."

The Weeks Formation is correlated with its type locality as measured by Bentley (1958, p. 42-43) and Robison (1958, in Bentley, 1958) based on lithology and stratigraphic position. Robison (1958, written communication) places the Weeks Formation in the *Cedaria* zone at the House Range, Utah. However, in the Silver Island Mountains the fauna identified by Lochman-Balk (1958, written communication) indicates that the Weeks Formation is in the lower half of the *Crepicephalus* zone. The Weeks seems to transcend time when traced northward in the Cordilleran miogeosyncline.

The Weeks Formation is also correlated with the Lamb Dolomite of the Deep Creek Range, with the lower half of the Hamburg Dolomite of Eureka, Nevada, and with approximately the lower half of the Opex Dolomite of central Utah (Bentley, 1958, p. 13).

Measured section. —

Section of the Weeks Formation in NW1/4 sec. 30, T. 2 N., R. 17 W. (unsurveyed)

Cambrian:
Notch Peak Formation.
Paraconformity.

Weeks Formation:

Unit	Description	Feet
7.	Limestone, medium-gray to medium bluish-gray; weathers olive gray; very fine-crystalline; and anastomosing thin seams and lenses of tan to reddish-brown argillaceous material; thin- to medium-bedded; irregular bedding planes; forms slope; trilobite hash at base of unit	79
6.	Limestone, medium-gray; weathers light to dark-gray; fine-crystalline; argillaceous; thin-bedded; irregular bedding planes; gray mottling; occasional chert nodules; non argillaceous limestone is 3 inches to 2 feet in thickness and is interbedded with fissile, iron coated, argillaceous limestone which is 3 to 5 inches in thickness; forms cliff	46
5.	Mudstone and siltstone, moderate yellowish tan to moderate-brown, fissile, shaly; liesegang rings; forms slope	4
4.	Limestone, medium blue-gray; weathers light to medium blue gray; fine- to medium-crystalline; massive	17
3.	Dolomite, light-gray; weathers light olive gray; medium-crystalline, massive; vugs filled with mineral dolomite	55
2.	Limestone, white; medium-crystalline; recrystallized; seams of brown argillaceous material; massive	41
1.	Dolomite, medium light-gray; weathers light olive gray; medium-crystalline, very coarse-crystalline in upper 15 feet of unit; massive	67
	Total Weeks Formation	309

Marjum Limestone.

Notch Peak Formation

History of nomenclature. — Walcott (1908a, p. 9) named the Notch Peak Limestone of Cambrian age for 1490 feet of massive, arenaceous, gray limestone above the Orr Formation in the House Range, Utah.

Bentley (1958) has studied the section in the House Range and believes that the upper 375 feet of the Orr Formation of Walcott (1908b, p. 175-176) is actually Notch Peak Limestone. Bentley (1958, pl. 2) has identified approximately 150 feet of strata below the foregoing 375 feet as Dunderberg Shale which Walcott (1908b) had included in the Orr Formation. Bentley's correlations are based on lithology and stratigraphic position.

Bentley (1958) states that the most characteristic feature of the Notch Peak Limestone is the presence of chert, especially in the lower half of the formation, generally in the form of nodules.

Because the Notch Peak is lithologically heterogeneous in the Silver Island Mountains it is referred to as the Notch Peak Formation.

Distribution. — The Notch Peak Formation is well exposed near Jenkins Peak in Silver Island and Tetzlaff Peak in the Leppy Range (see pls. 1A, 1B, and fig. 3).

Character and thickness. — Lithologically the formation is composed of almost equal proportions of limestone and dolomite. Limestone is more abundant toward the base, and dolomite is more abundant toward the top. Chert nodules and stringers are common in the lower half of the formation but rare in the upper half (see pl. 3).

The general description of the limestone and dolomite in the Notch Peak Formation is as follows: massive, occasionally argillaceous, fine- to medium-crystalline, light-gray to light bluish-gray limestone which weathers light to medium gray and medium bluish gray; and massive, arenaceous, fine- to coarse-crystalline, medium-gray to medium bluish-gray dolomite which weathers light gray, tan, and grayish black.

The upper 451 feet of the Notch Peak deserves special mention as these beds form a marker sequence which is referred to by the writer as the dolomite member of the Notch Peak Formation. This sequence of dolomites is banded in appearance and it is easily traced throughout its exposure.

The Notch Peak Formation aggregates 1,864 feet in thickness.

Stratigraphic relations. — The Notch Peak Formation paraconformably overlies the Weeks Formation and the contact is placed at the top of the thin-bedded, argillaceous limestone slope of the Weeks Formation and at the base of the first massive limestone cliff of the Notch Peak.

The conformable contact between the dolomite member of the Notch Peak and the overlying Lower member of the Garden City Formation is placed at the top of the cliff-forming, banded dolomite of the Notch Peak; and at the base of the slope-forming, argillaceous limestones, and intraformational limestone conglomerates of the Garden City Formation. This contact is also the system boundary between the strata of Cambrian and Ordovician ages.

Paleontology. — R. A. Robison (1958, writtten communication) has identified the following fauna collected from the Notch Peak Formation in the Silver Island Mountains.

Unit 5—*Illaenurus* sp.
Pseudoagnostus sp.
Ptychaspis? sp.
Unit 7—*Saukiella* sp.
Hyolithes sp.
Unit 10—*Eorthis desmopleura*
Owenella antiquata

Age and correlation. — The Notch Peak has been assigned a middle and late Franconian through Trempealeauian age by Robison (1958, written communication) by faunal evidence.

The Notch Peak of the Silver Island Mountains has been correlated by Bentley (1958) with its type locality based on lithology and stratigraphic position. Robison (in Bentley, 1958) has correlated the Notch Peak with its type locality by faunal evidence.

The dolomite member of the Notch Peak Limestone is correlated by the writer with the dolomite portion of the Chokecherry Dolomite of Gold Hill, Utah, based on lithology and stratigraphic position. The dolomite portion of the Chokecherry Dolomite has been tentatively correlated by Bick (1959) with the type Notch Peak Limestone based on lithology and stratigraphic position.

Bentley (1958) has correlated the Notch Peak with the following formations: the Ajax Limestone of central Utah; the windfall Formation of Eureka, Nevada; the upper part of the Mendha Limestone of Pioche, Nevada; and with that part of the St. Charles Formation above the Worm Creek Quartzite member of northern Utah.

Measured section. —

Section of the Notch Peak Formation in NW¼ sec. 30, T. 2 N., R. 17 W., (unsurveyed); and S¼ sec. 19, NE¼ sec. 19, T. 2 N., R. 17 W. (unsurveyed)

Ordovician:

Pogonip Group:

Garden City Formation.

Cambrian:

Notch Peak Formation:

Dolomite member:

Unit	*Description*	*Feet*
16.	Dolomite, medium bluish-gray; weathers dark bluish gray to black; medium-crystalline concretionary structures in basal 4 feet which are elliptical and spherical (¼-inch to ⅜-inch in diameter; unit spangled with faint ¼-inch elongate, grayish-rods; forms cliff	39
15.	Dolomite, medium to light bluish-gray; weathers light gray to tan; coarse-crystalline; very arenaceous; massive; vugs filled with mineral dolomite; "zebra" banding with mineral dolomite; sharp contact with unit 4; forms cliff	55
14.	Dolomite, medium blue-gray; weathers gray to black to a medium gray tan; fine-crystalline; massive (beds 4 to 10 feet in thickness); "zebra" banding with mineral dolomite; a few chert stringers about a foot apart; a few bleached zones near top of unit; forms cliff	269
13.	Dolomite, medium-gray; weathers olive gray; medium- to coarse-crystalline; arenaceous; cross-bedded and 1 foot of intraformational conglomerate at 7 feet above the base; forms cliff	88
	Total Dolomite member	451
12.	Limestone, medium-gray; weathers medium to dark gray; coarse-crystalline; occasional irregular, red to brownish-yellow argillaeous stringers; many small cavities at base	7
11.	Dolomite, medium light-gray; weathers dark yellowish orange to dark yellowish brown; medium-crystalline; arenaceous	6
10.	Limestone and siltstone, interbedded; limestone, medium light-gray to dark-gray; weathers medium dark gray; fine-crystalline; and moderate yellowish-brown siltstone which contains liesegang rings; platy and shaly; forms slope; fossils at base of unit — *Eorthis desmopleura, Owenella antiquata*	65
9.	Limestone, medium bluish-gray; weathers medium gray to yellowish gray, fine crystalline; arenaceous; medium-bedded	19
8.	Dolomite, medium-gray; weathers medium yellowish brown; medium-crystalline; arenaceous; massive; vugs filled with mineral dolomite; siltstone unit 1-foot in thickness at base; forms cliff	240

7.	Limestone, light bluish-gray; weathers medium bluish gray; coarse-crystalline at base to very fine-crystalline 74 feet above base; grayish orange to moderate yellowish brown argillaceous material along partings which ranges from ½-inch to 6 inches in thickness (averages 1 to 2 inches); unit very clastic; thin-bedded; thin beds of intraformational conglomerate present but not common; surface of limestone weathers knobby and irregular; weathering out of argillaceous material leaves groves and furrows; oölitic bed at base; fossils — *Saukiella* sp., *Hyolithes* sp.	172
6.	Dolomite, medium bluish-gray; weathers light gray; fine- to medium-crystalline; calcareous; this unit changes laterally into a dark greenish-gray limestone which weathers medium light gray; upper portion of unit becomes arenaceous; massive; vugs filled with mineral dolomite; laminations and faint cross-bedding; oölitic bed 2 feet in thickness at 86 feet above base; occasional chert nodules and stringers above oölitic bed; algal bed 154 feet above base	221
5.	Limestone, medium dark-gray; fine crystaline; thin-bedded; irregular bedding planes; moderate brown argillaceous material along partings; occasional thin seams of intraformational congolmerate; many chert nodules and discontinuous lenses of chert; forms steep slope; fossils — *Illaenurus* sp., *Pseudoagnostus* sp., *Ptychaspis?* sp.	48
4.	Limestone, light-gray; weathers light gray to medium light gray; very fine-crystalline to sub-lithographic; massive; small amounts of argillaceous material along partings; chert nodules; oölitic bed 9 inches in thickness 20 feet above base of unit	72
3.	Limestone, medium dark-gray; fine-crystalline; platy to thin-bedded; irregular bedding planes; moderate brown argillaceous material along partings; fucoids	5
2.	Limestone, light-gray; weathers light gray to medium light gray; 40 feet above base limestone weathers grayish blue; very fine-crystalline to sub-lithographic; massive; small amounts of argillaceous material along irregular partings, which are 1/32- to 1/16-inch in thickness; 40 feet above the base are occasional grayish-black chert nodules (1-inch in diameter) which weather dusky yellowish brown, chert bands present but discontinuous; at 249 feet above base chert becomes more abundant, at 321 feet above base there is very little chert, at 372 feet above base there is occasional chert; occasional "zebra" banding with mineral dolomite; forms cliff	373
1.	Limestone, grayish-blue; weathers light to medium bluish gray; fine-crystalline; thin-bedded; moderate yellowish tan weathering argillaceous material in thin seams and lenses about ½- to 1-inch in thickness which are slightly anastomosing; occasionally the argillaceous material weathers moderate reddish brown and is platy; 121 feet above the base the lithology becomes less argillaceous and is laterally discontinuous; 37 to 46 feet above base of unit are three white calcite bands which are each 1-foot in thickness, 37 feet above the top of the third band is a fourth band and 10 feet above this is a fifth band; forms cliff	185
	Total Notch Peak Formation	1,864

Paraconformity.

Weeks Formation.

ORDOVICIAN SYSTEM

The Ordovician System of the Silver Island Mountains is represented by eight formations which aggregate about 5,000 feet in thickness. Stratigraphic terminology is derived from northeast and western Utah, and eastern Nevada.

Pogonip Group

History of nomenclature. — The Pogonip was originally defined by Clarence King (1878, p. 188) to include all the sedimentary rocks between the Prospect Mountain Quartzite of Early Cambrian age and the Eureka Quartzite of Middle Ordovician age. The type locality is in the White Pine mining district about 30 miles southeast of Eureka, Nevada. Hague (1883, p. 260; 1892, pp. 48, 49) later redefined the Pogonip in the same locality to include only the sedimentary rocks between the Cambrian Dunderberg Shale and the Ordovician Eureka Quartzite.

Usage by Sharp (1942, p. 657) and other workers throughout Nevada and parts of California and Utah tended to restrict the Pogonip to the Ordovician System. Following detailed stratigraphic work, L. F. Hintze (1949; 1951, p. 11) and Easton and others (1953, fig. 2) proposed that the Pogonip be considered as a group, to include only the Ordovician portion of the section as redefined by Hague.

Nolan and others (1956, pp. 20, 24) also proposed that the Cambrian portion of the redefined Pogonip of Hague be named the Windfall Formation and that the Pogonip be restricted to the Ordovician.

At the new type locality of the Eureka Quartzite along the west base of Lone Mountain, 15 miles northwest of Eureka, Nevada, the top of the Pogonip Group is placed at the base of the Eureka Quartzite (Kirk, 1933, p. 34). Webb (1958, p. 2341) has studied the new type locality and places the lower 40 feet of the Eureka Quartzite within the Copenhagen Formation. This would place the top of the Pogonip Group at the base of the Copenhagen Formation.

Hintze (1951, p. 11, 12) has divided the Pogonip Group into six formations in western Utah and eastern Nevada. From oldest to youngest they are House Limestone, Fillmore Limestone, Wahwah Limestone, Juab Limestone, Kanosh Shale, and Lehman Formation.

Merriam (Nolan and others, 1956, p. 25-29) has divided the Pogonip Group into three formations in the vicinity of Eureka, Nevada. From oldest to youngest they are the Goodwin Limestone, Ninemile Formation, and Antelope Valley Limestone.

Lowell (1958) has divided the Pogonip Group into five lithologic units in central and eastern Nevada. From oldest to youngest they are lower limestone member, middle limestone member, upper limestone member, "Kanoshian", and Lehman Formation.

Hintze (1959) believes that Pogonip Group terminology should be used for the Ibex Basin of southwestern Utah, and Garden City Formation terminology for the northern Utah Basin. Because the Silver Island Mountains are geographically in the western portion of the northern Utah Basin, the Garden City Formation is recognized in the Silver Island Mountains as a formation within the Pogonip Group.

In the Silver Island Mountains the Pogonip Group is represented by the following formations: Garden City Formation which is divided into a Lower member and an Upper Cherty member, Kanosh Shale, Lehman Formation, tongue of Swan Peak Quartzite, and Crystal Peak Dolomite. The writer believes that the current definition of the Pogonip Group permits placing the foregoing formations within this group in the area of the Silver Island Mountains.

The Garden City Formation was originally defined by Richardson (1913, pp. 408-409) for its exposure in Garden City Canyon west of Bear Lake. The Garden City Formation was described as overlying the St. Charles Formation and overlain by the Swan Peak "quartzite". However, Williams (1948, p. 1136) found shaly and silty beds of a basal member of the Swan Peak formation directly overlying the Garden City formation. Ross (1951, p. 7) has divided the Garden City formation into two members; the Lower member is predominantly an intraformational limestone conglomerate, and the Upper Cherty member is less conglomeratic but very cherty.

The Kanosh Shale was named by Hintze (1951, p. 18) after a village in central Utah. Hintze (1951, p. 18) defined the Kanosh Shale as a fissile, yellowish-brown, olive, gray, or pink shale with intercalated thin-bedded limestones; and with several thin-bedded, orange weathering siltstones and fine sandstones occurring in the upper part. The Kanosh Shale is very fossiliferous. It is distinguished from the underlying Juab Limestone because of its shaly detritus. The Kanosh Shale is overlain by the Lehman Formation.

In the Snake Range near the Lehman Caves, Nevada, Hintez (1951, p. 19) named and defined the Lehman Formation as a fossiliferous, thin- to thick-bedded, blue-gray calcilutite. Hintze (1951, p. 19) states:

> "In the Ibex area the base of the Lehman formation is the base of the lowest interbedded sandstone ledge, and the upper limit of the formation is the top of the highest calcilutite beneath the Swan Peak? quartzite ledges."

The Swan Peak of northern Utah and southeastern Idaho was defined by Richardson (1913) as the beds between the Garden City Limestone and the Upper Ordovician dolomites. Additional work by Williams (1948, p. 1136) and Ross (1951, p. 37) showed the Swan Peak to be composed of a more varied lithology than the original definition implied. The Swan Peak consists of a lower intercalated sandstone and shale member and an upper quartzite member. Webb (1956) defined the Watson Range tongue of the Swan Peak Quartzite as the quartzite above the Lehman Formation at Ibex. It is described as a typically reddish brown weathering, iron oxide-, calcite-, and silica-cemented quartz sandstone and quartzite occurring in thick to massive beds prominently weathered into ledges.

Webb (1956) defined the dolomite above the Watson Ranch tongue of the Swan Peak Quartzite as the Crystal Peak Dolomite for its exposure north of Crystal Peak, Confusion Range, Utah. A coral biostrome of *Eofletcheria* sp., 2 feet in thickness, occurs 20-25 feet below the top of the Crystal Peak. Hintze (1951, p. 20) reports that the *Eofletcheria* zone is in the uppermost Lehman beds in Nevada and that this is a younger fauna than any recognized in the Lehman Formation in Utah. Kellogg (1958, manuscript in preparation) states that a 64-foot dolomite interval at the top of the Lehman Formation at Shingle Pass in the southern Egan Range, Nevada, can be traced along strike into typical Lehman Formation.

Distribution. — In the Silver Island Mountains the Pogonip Group is well exposed on Tetzlaff Peak in the eastern portion of the Leppy Range and on Jenkins Peak in the southern portion of Silver Island (see pls. 1A, 1B, and figs. 3, 4).

Character and thickness. — The Pogonip Group aggregates 4,188 feet in thickness in Silver Island (see pl. 3).

The basal part of the Lower member of the Garden City Formation is an argillaceous, arenaceous, calcareous, medium blue-gray dolomite. The remainder of the Lower member consists of argillaceous, medium- to coarse-crystalline, medium-blue limestone, and occasional interbeds of intraformational limestone conglomerate which increase upwards. The member is thin- to medium-bedded. This member aggregates 1,326 feet in thickness.

The Upper Cherty member of the Garden City Formation consists of orange-mottled, argillaceous, fine- to coarse-crystalline, dark blue-gray limestone which contains chert beds, nodules, and stringers, throughout the member with the exception of the upper 330 feet. The member is thin- to thick-bedded and aggregates 1,806 feet in thickness.

Th Kanosh Shale consists of calcareous, orange-brown argillites and occasional seams and lenses of dark-gray limestone. The formation is platy to thin-bedded and forms a slope. It is a key marker bed and aggregates 166 feet in thickness.

The Lehman Formation is a orange and maroon mottled, argillaceous, fine- to medium-crystalline, dark blue-gray to blue-black limestone. It is thin-bedded and aggregates 768 feet in thickness.

There is a 3-foot tongue of Swan Peak Quartzite which is a quartzose sandstone.

The Crystal Peak Dolomite consists of interbedded arenaceous, fine-crystalline, dark-gray dolomite; and limestone similar to the limestone of the Lehman. The Crystal Peak Dolomite aggregates 119 feet in thickness.

Stratigraphic relations. — The oldest lithologic member of the Pogonip Group, the Lower member of the Garden City Formation, is a slope forming, argillaceous limestone and intraformational limestone conglomerate which contrasts with the conformably underlying cliff-forming, medium-gray dolomites of the dolomite member of the Cambrian Notch Peak Formation.

The conformable contact between the Kanosh Shale and overlying Leh- Cherty member of the Garden City Formation is placed at the base of the first cliff-forming, dark blue-gray limestone which contains chert beds

The conformable contact between the cliff-forming Upper Cherty member of the Garden City and the overlying slope-forming Kanosh Shale is placed at the base of the first argillite bed.

The conformable contact between the Kanosh Shale and overlying Lehman Formation is placed at the top of the last argillite bed and the base of the first orange- and maroon-mottled blue-black limestone.

The conformable contact between the Lehman Formation and the overlying tongue of Swan Peak Quartzite is placed at the base of the 3-foot quartzose sandstone. The top of this quartzose sandstone bed is the conformable contact between the tongue of Swan Peak Quartzite and the overlying Crystal Peak Dolomite.

The conformable contact between the Crystal Peak Dolomite and the overlying "shaly quartzite member" of the Eureka Quartzite is placed at the top of the highest dolomitic limestone and the base of the first quartzite ledge.

Paleontology. — The upper portion of the Lower member of the Garden City Formation yielded the following fauna which was identified by Hintze (1957, written communication).

Zone G—*Psalikilus* sp.
Protopliomerops sp.
Zone H—*Trigonocerca typica*
Trematorthis sp.

Hintze (1957, written communication) identified the following fauna from the Upper Cherty member of the Garden City Formation.

Zone J—*Pseudomera* sp.

Dimeropygiella caudanodosa
Carolinites genacinaca
Hesperonomia antelopensis
cystoid plates
Lachnostoma latucelsum

Hintze (1957, oral communication) also identified *Nevadocoelia* from the Upper Cherty member and the writer identified *Hormotoma* sp?.

The writer identified the following fauna from the Kanosh shale.

Zone M—*Receptaculites* sp.
Eleutherocentrus petersoni
Didymograptus sp.
Bathyurellus pogonipensis
?Goniotelus ludificatus
Pseudomera kanoshensis
Orthis swanensis?
Orthis michaelis
Protocycloceras debilis
fucoids

Hintze (1957, oral communication) identified *Bathyurellus feitleri* from this formation.

The writer identified the following fauna from the Lehman Formation.

Zone N—*Leperditia* sp.

Cybelopsis sp.
Eleutherocentrus sp.
Helicotoma sp?

R. H. Waite (1958, written communication) identified *Lichenaria* from the 2-foot coral biostrome of the Crystal Peak Dolomite. The writer believes this 2-foot coral biostrome to be faunal zone O of Hintze (1951, p. 21) because of the stratigraphic position of the biostrome and the similarity of *Eofletcheria* (faunal zone O) to *Lichenaria*. The writer believes the application of two generic names may be due to a difference of opinion or to identification.

Age and correlation. — The Lower member is assigned a Canadian age (Ross, 1951).

The Lower member of the Garden City Formation in the Silver Island Mountains is correlated with its type locality west of Bear Lake, Utah, based on lithology, stratigraphic position, and faunal zones G and H. The Lower member is also correlated with the lower three units of the Garden City Formation in the Stansbury Mountains as described by Rigby (1958, p. 27).

Ross (1951, p. 31) has placed the Canadian-Chazyan boundary between faunal zones K and L. Thus the Upper Cherty member is assigned a Canadian-Chazyan age by Ross (1951, p. 31). However, subsequent work by Cooper (1956, chart 1) has established the presence of a post-Canadian and pre-Chazyan stage denoted as Whiterock. Cooper (1956, p. 130) has tentatively assigned the Kanosh Shale to the Whiterock stage. Kindle and Whittington (1958, p. 328) seem to substantiate this correlation. The writer has inferred from the foregoing that the Canadian-Whiterock boundary lies between faunal zones K and L. Thus the writer assigns a Canadian-Whiterock age to the Upper Cherty member.

The Upper Cherty member of the Garden City Formation is correlated with its type locality west of Bear Lake, Utah, based on lithology, stratigraphic position and the presence of faunal zone J.

Cooper (1956, p. 130) has tentatively assigned the Kanosh Shale a Whiterock age.

The Kanosh Shale is correlated with the lower portion of its type locality in cetnral Utah based on lithology, stratigraphic position, and faunal zone M. The Kanosh Shale of the Silver Island Mountains is also correlated with the shaly part of the Swan Peak Formation in Logan Canyon, Utah.

Hintze (1951) assigned the Lehman Formation, and Swan Peak Quartzite a Chazyan age.

The Lehman Formation is correlated with its type locality in the Snake Range, Nevada, based on lithology, stratigraphic position, and faunal zone N.

The tongue of Swan Peak Quartzite is correlated with the quartzitic part of the Swan Peak Formation in its type locality in northern Utah based on lithology and stratigraphic position.

Webb (1958, p. 2366) believes the *Eofletcheria* zone O in the Crystal Peak Dolomite approximates the Chazyan-Bolarian boundary. The Crystal Peak Dolomite is correlated with its type locality in the Confusion Range, Utah, based on lithology, stratigraphic position, and faunal zone O.

Measured sections. —

Section of the Crystal Peak Dolomite in
NW1/4 sec. 9, T. 2 N., R. 17 W. (unsurveyed)

Ordovician:

Eureka Quartzite:

Shaly Quartzite member.

Pogonip Group:

Crystal Peak Dolomite:

Unit	Description	Feet
8.	Limestone, dark- to light-gray; fine-crystalline; dolomitic, argillaceous; thin-bedded; maroon mottling; forms slope	18
7.	Dolomite, buff and gray; weathers medium gray; fine-crystalline; argillaceous; thin-bedded; forms ledge	4
6.	Limestone, medium-gray fine-crystalline; argillaceous; thin-bedded; forms slope	8
5.	Limestone, dark-gray weathers tan to buff; medium-crystalline; argillaceous; thin-bedded; fossils — bioherm of *Lechinaria* sp.	2
4.	Dolomite, medium-gray; weathers light gray; fine-crystalline; iron coated patches	4
3.	Limestone, as unit 3 of Lehman Formation	16
2.	Dolomite, dark-gray to black; weathers light-gray to black; fine-crystalline; arenaceous; silty; "zebra" banding with mineral dolomite; 3-foot bed of limestone as unit 3 of Lehman Formation at 10 feet above base; forms cliff	24
1.	Limestone, as unit 3 of Lehman Formation	43
	Total Crystal Peak Dolomite	119

Swan Peak Quartzite tongue.

Section of the Swan Peak Quartzite tongue in NW1/4 sec. 9, T. 2 N., R. 17 W. (unsurveyed)

Ordovician:

Pogonip Group:

Crystal Peak Dolomite.

Swan Peak Quartzite tongue:

Unit	Description	Feet
4.	Sandstone, light-gray quartz and dark-gray cement; medium-grained, well-rounded; quartzose, calcareous; light orange-brown mottling; thin-bedded, cross-bedded	3
	Total Swan Peak Quartzite tongue	3

Lehman Formation.

Section of the Lehman Formation in sec. 9, T. 2 N., R. 17 W. (unsurveyed)

Ordovician:

Pogonip Group:

Swan Peak Quartzite tongue.

Lehman Formation:

Unit	Description	Feet
3.	Limestone, dark-gray to blue-black; weathers dark blue gray to blue black; fine-crystalline; platy to thin-bedded; 6-inch bed of calcareous, quartzose sandstone at base; argillaceous; extreme orange, purple and maroon mottling seams of anastomosing argillaceous material; forms ledge	528
2.	Limestone, dark blue-gray; fine- to medium-crystalline; very argillaceous; platy to thin-bedded; 1- to 2-inch seams of argillaceous material; orange and maroon mottling; cubes of hematite; trilobite hash; fossils — *Leperditia* sp., *Cybelopsis* sp., and *Eleutherocentrus*	65
1.	Limestone, blue-black; fine-crystalline; argillaceous; platy to thin-bedded; orange and maroon mottling; fossils — ostracods, trilobites, and fucoids	175
	Total Lehman Formation	768

Kanosh Shale.

Section of the Kanosh Shale in SW1/4 sec. 9, T. 2 N., R. 17 W. (unsurveyed)

Ordovician:

Pogonip Group:

Lehman Formation.

Kanosh Shale:

Unit	Description	Feet
1.	Argillite, medium orange-brown; calcareous; 1- to 3-inch seams and lenses of dark-gray limestone; weathers medium orange brown to dark blue gray; fine crystalline; and occasional dark gray slate; weathers medium gray tan; entire unit shaly to thin-bedded; forms slope; fossils — *Receptaculites* sp., *Didymograptus bifidus?, Protocycloceras debilis, Lingulella bellisculpta? Orthis swanensis?, Orthis michaelis, Eleutherocentrus petersoni, Bathyurellus pogonipensis, Bathyurellus feitleri, ?Goniotelus ludificatus, Pseudomera kanoshensis,* fucoids	166
	Total Kanosh Shale	166

Garden City Formation:

Upper Cherty member.

Section of the Garden City Formation in E1/2 sec. 17 and NW1/4 sec. 20, T. 2 N., R. 17 W. (unsurveyed)

Ordovician:

Pogonip Group:

Kanosh Shale.

Garden City Formation:

Upper Cherty member:

Unit	Description	Feet
8.	Limestone, dark blue-gray; weathers purple orange; fine-crystalline; anastomosing argillaceous material; medium tan; thick-bedded; forms cliff	331
7.	Limestone, dark blue-gray; fine- to medium-crystalline; extremely mottled with argillaceous material; light orange; thin -to thick-bedded; chert nodules and stringers, less chert than unit 1; forms cliff; fossils at 85 feet above base of unit; fossil — *Lachnostoma latucelsum*	159
6.	Limestone, dark blue-gray; fine-crystalline; extremely mottled with argillaceous material, light orange; thin- to thick-bedded; forms cliff; fossils at 135 feet above base; fossils — *Hesperonomia, Dimeropygiella caudanodosa?*	188
5.	Limestone, medium gray; fine- to very coarse-crystalline; argillaceous; orange and maroon mottling; contains bedded chert stringers; dark gray; weathers dark orange brown; 30 feet of chert bearing limestone alternates with 35 feet of non-chert bearing limestone from base to top of unit; chert bearing limestone contains chert which is 1 to 2 inches in thickness separated by limestone which is 1 to 2 inches in tihckness; 472 feet above base is a fault of small displacement; 495 feet above base is a bed of intraformational conglomerate which is 5 feet in thickness; thin- to medium-bedded; forms cliff; fossils — *Nevadocoelia* zone 2 feet in thickness 553 feet above base	1,128
	Total Cherty member	1,806

Lower member:

Unit	Description	Feet
4.	Limestone and intraformational conglomerates; medium- to dark-blue; weathers medium blue; fine-grained, argillaceous material throughout and iron coated bands, argillaceous material occurs as stringers of siltstone which weather a yellowish tan to dark brown; intraformational conglomerate pebbles flat with rounded edges; thin-bedded, occasionally platy; laminated; light tan mottling; occasional beds of fine-grained, light-gray quartzite which weather rusty brown; small hematite crystals; chert nodules at 137 feet above base; at 209 feet above base limestone becomes coarse-grained; forms steep slope; fossils — fucoids and brachiopods	533
3.	Limestone, light- to medium-gray, weathers medium gray; coarse-crystalline; massive bedded; tan and light maroon mottling, forms cliff	53
2.	Limestone, medium- to dark-blue; weathers medium blue; medium crystalline; chert nodules; anastomosing lenses of argillaceous material, weathers light yellowish brown; thin- to medium-bedded; maroon mottling; and intraformational conglomerate from 444 to 512 feet above base, ½- to 1-inch rounded pebbles; forms slope	680
1.	Dolomite, medium blue-gray; weathers medium gray, calcareous, arenaceous, veinlets filled with mineral dolomite; sand content presents sugary texture on weathered surface, sand increases in content higher in section and imparts distinct brown hue; occasional chert nodules; argillaceous material increases upward and occurs on partings ¾-inch in thickness; occasional limestone lenses, medium blue-gray, fine-crystalline; lower contact with dolomite member of Notch Peak very sharp	60
	Total Lower member	1,326
	Total Garden City Formation	3,132

Cambrian:

Notch Peak Formation:

Dolomite member.

Eureka Quartzite

History of nomenclature. — Hague (1883, p. 262; 1892, p. 54-57). proposed the name Eureka Quartzite for a prominent white quartzite in the vicinity of Eureka, Nevada. Because of the inadequacy of the outcrops in the Eureka district proper, Kirk (1933, p. 34) proposed that a new type locality be designated for the Eureka Quartzite along the west base of Lone Mountain which is about 15 miles northwest of Eureka. The Geological Survey has accepted this redesignation (Nolan and others, 1956, p .29).

Webb (1958, p. 2341) has studied the new type locality of the Eureka Quartzite and restricted the Eureka Quartzite to the upper 181 feet of Kirk's total thickness of 225 feet. Webb (1958, p. 2341) places the lowermost 40 feet of the Eureka Quartzite of Kirk, the sandy dolomites, within the Copenhagen Formation. The restricted Eureka Quartzite of Webb is divided

into three members at Lone Mountain by Webb (1958, p. 2341) as follows: "lower discolored quartzite member", which is the lower 35 feet of yellowish-brown, dark reddish-brown, whitish-weathering quartzite; "white quartzite member", which consists of 95 feet of whitish weathering quartz sandstones and massive to thinly bedded white quartzite which weathers to light shades of red and orange on joint and outcrop faces; and "upper gray quartzite member", which consists of 51 feet of whitish quartz sandstone which weathers light gray to brownish-gray and becomes grayer, darker brown-weathering, and forms a more continuous cliff upwards, and at the top becomes a dark bluish-gray, medium-grained quartz sandy dolomite.

On the west side of the Grant Range, Nevada, Webb (1958, p. 2347-2348) recognized two new members of the Eureka quartzite which overlie rock equivalents of the three quartzite members of the type area. These two new members are in ascending order: "upper sandstone member", which consists of 50 feet of light yellow-weathering white quartz sandstone; and "upper vitreous quartzite member", which consists of 85 feet of vitreous quartzite and sandstone.

In the above locality, Webb (1958, p. 2348) has also defined the "shaly quartzite member" as a lower unit of thinly bedded friable quartz sandstones and intercalated siltstones, shales, and dolomites. This member totals 90 feet of exposed thickness and is separated from the overlying type Eureka equivalent quartzite by a 10-foot concealed zone.

The Eureka Quartzite is divided into four lithologic units in the Silver Island Mountains. From oldest to youngest, they are: "shaly quartzite member", "lower discolored quartzite member", "white and upper gray quartzite members undifferentiated", and "upper sandstone member."

Distribution. — In the Silver Island Mountains, the Eureka Quartzite is well exposed on Silver Island (see pl. 1A and figs. 4, 5, and 6). The Eureka Quartzite is also exposed at the head of Millard Canyon in the eastern portion of the Leppy Range.

Character and thickness. — The Eureka Quartzite aggregates 370 feet on Silver Island (see pl. 3).

The "shaly quartzite member" aggregates 127 feet and consists of interbedded fine grained, white, tan, blue and gray quartzite which weathers buff, orange brown, and light gray; purple and maroon mottled argillite and siltstone; and thin-bedded, arenaceous, fine-crystalline, gray limestone.

The "lower discolored quartzite member" aggregates 12 feet and consists of interbedded fine-grained, white quartzite which weathers pink; and quartzose, fine-grained, medium-gray sandstone which weathers brown and orange.

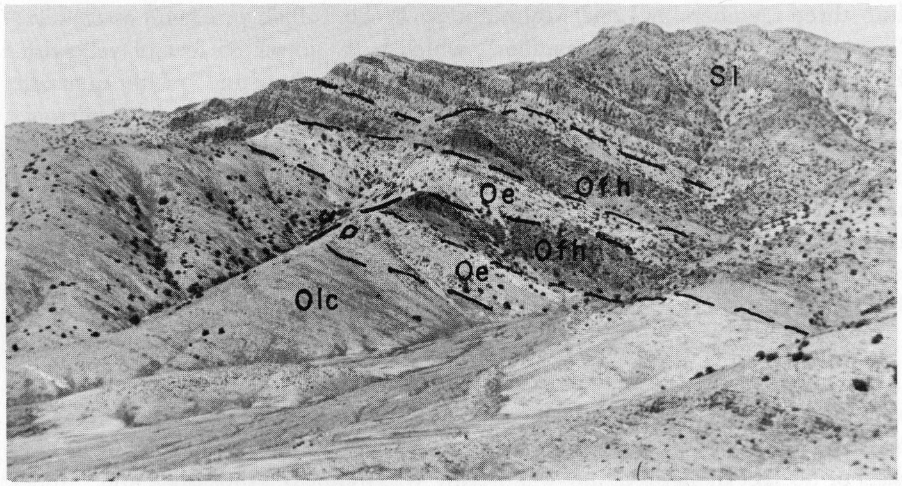


Fig. 4. View looking west, Campbell Peak on right. Olc, Lehman Formation, Tongue of Swan Peak Quartzite, and Crystal Peak Dolomite undifferentiated; Oe, Eureka Quartzite; Ofh, Fish Haven Dolomite; Sl, Laketown Dolomite.

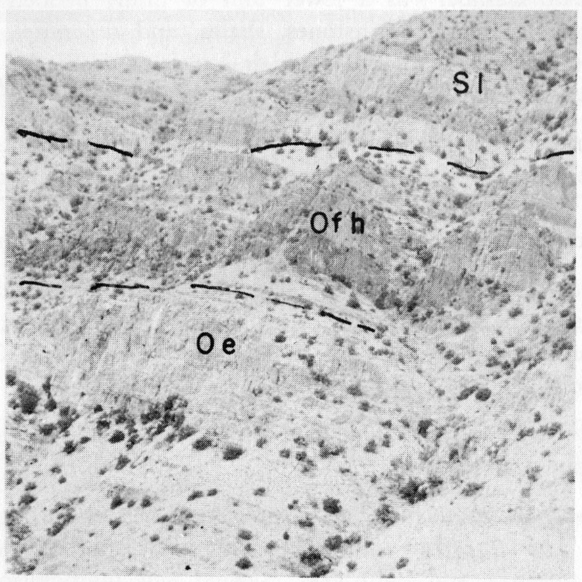


Fig. 5. View looking northwest, Campbell Peak on right. Oe, Eureka Quartzite; Ofh, Fish Haven Dolomite; Sl, Laketown Dolomite.

The "white and upper gray quartzite members undifferentiated" aggregate 201 feet and consist of massive fine-grained, blue, white quartzite which weathers orange and gray blue.

The "upper sandstone member" aggregates 30 feet and consists of quartzose, fine- to medium-grained, light tan sandstone with occasional interbeds of fine-grained, gray-blue quartzite.

Stratigraphic relations. — The conformable contact between the "shaly quartzite member" of the Eureka Quartzite and the underlying Crystal Peak Dolomite of the Pogonip Group is drawn at the top of the last dolomitic limestone and the base of the first sandstone.

The type Eureka Quartzite members, deposited from Medial to Late Trentonian time may bevel the "shaly quartzite member" which is either Chazyan or Bolarian in age, probably the latter (Webb, 1958, pp. 2366-2367). This possible unconformable contact between the "lower discolored quartzite member" and the underlying "shaly quartzite member" is placed at the top of the last siltstone and the base of the first continuous sequence of quartzite and sandstone.

The conformable contact between the "white and upper gray quartzite members undifferentiated" and the underlying "lower discolored quartzite member" is placed at the base of a massive gray-blue and white quartzite which weathers orange.

The conformable contact between the "upper sandstone member" and the underlying "white and upper gray quartzite members undifferentiated" is placed at the base of a sequence of interbedded quartzose sandstones and quartzites.

The paraconformable(?) contact between the "upper sandstone member" of the Eureka Quartzite and the overlying Fish Haven Dolomite is placed at the top of the last quartzose sandstone and the base of the first arenaceous dolomite.

Paleontology. — No fossils were found in the Eureka Quartzite.

Age and correlation. — The "shaly quartzite member" is probably Bolarian (Webb, 1958, p. 2368) in age.

The "shaly quartzite member" has been interpreted by Webb (1958, p. 2364) as grading into successively higher Pogonip carbonates westward and he assumes that the highest beds of the "shaly quartzite member" were continuous with the Copenhagen Formation, especially with the sandstone member of the latter.

Webb (1958, p. 2368) assigns the following ages to the other members of the Eureka quartzite:

> "The type Eureka quartzite, with its correlatives, is medial and later Trentonian, and the higher Eureka members and equivalent carbonatites of central Nevada are latest Trentonian, and possibly early Cincinnatian."

The "lower discolored quartzite member" and "white and upper gray quartzite members undifferentiated" are correlated with the restricted type Eureka Quartzite as subdivided by Webb (1958, p. 2341). The "upper sandstone member" is correlated with its type locality in the Grant Range, Nevada.

Measured section. —

Section of the Eureka Quartzite in
NW1/4 NW1/4 sec. 9, T. 2 N., R. 17 W. (unsurveyed)

Ordovician:

Fish Haven Dolomite.

Paraconformity?

Eureka Quartzite:

Upper Sandstone member:

Unit	*Description*	*Feet*
20.	Sandstone, gray; fine- to medium-grained; quartzose; maroon mottling; irregular bedding planes; forms slope	10
19.	Quartzite and quartzose sandstone, gray-blue; vitreous	4
18.	Quartzite and quartzose sandstone, dark-blue and light-tan, respectively; fine-grained; red mottling	11
17.	Sandstone, light tan; weathers orange; quartzose; smooth surface	5
	Total Upper Sandstone member	30

White and Upper Gray Quartzite members undifferentiated

Unit	*Description*	*Feet*
16.	Quartzite, light gray-blue speckled with dark blue spots	1½
15.	Quartzite, dark gray-blue; very fine-grained vitreous	3
14.	Quartzite; gray-blue and white; weathers orange to orange-brown; very fine- to fine-grained; and occasional 1- to 6-inch beds of quartzose, light pink and tan sandstone; red staining; weathers angular and blocky; massive bedded; forms cliff	197
	Total White and Upper Gray Quartzite members undifferentiated	201½

Lower Discolored Quartzite member

Unit	*Desription*	*Feet*
13.	Sandstone, as unit 11	½
12.	Quartzite, white; weathers maroon and pink; very fine-grained; vitreous	2
11.	Sandstone, medium gray; weathers brown and orange; fine-grained; quartzose; shaly	1
10.	Quartzite, as unit 8	8½
	Total Lower Discolored Quartzite member	12

Paraconformity?

Shaly Quartzite member

9.	Siltstone, as unit 7	1½
8.	Quartzite, gray-blue; weathers orange-brown, fine-grained; vitreous; massive	3
7.	Siltstone, shaly; maroon mottling, forms slope	30
6.	Quartzite and quartzose sandstone, blue; weathers light gray; fine-grained; occasionally vitreous; massive	6
5.	Quartzite, white to tan; weathers orange brown; fine-grained; platy; forms slope	27
4.	Limestone, medium gray; weathers gray to buff; fine-crystalline; arenaceous; thin-bedded; forms slope	16
3.	Sandstone, white to tan; weathers brown to light tan; fine-grained; quartzose	17½
2.	Argillite, purple; platy; maroon mottling; forms slope	17
1.	Quartzite, and quartzose sandstone, light gray; weathers buff and gray	8½
	Total Shaly Quartzite member	126½
	Total Eureka Quartzite	370

Pogonip Group:

Crystal Peak Dolomite.

Fish Haven Dolomite

History of nomenclature. — Richardson (1913, p. 407-409) named the Fish Haven Dolomite for exposures in Fish Haven Canyon west of Bear Lake, in southeastern Idaho. The Fish Haven Dolomite overlies the Swan Peak Formation and is overlain by the Laketown Dolomite in its type locality (Richardson, 1913). Richardson (1941, p. 17-18) distinguishes the Fish Haven Dolomite from the overlying Laketown Dolomite on the basis of color; the Fish Haven Dolomite being dark-gray to blue-black; whereas, the Laketown Dolomite is light-gray to white.

In the Logan quadrangle, Utah, Williams (1948, p. 137) distinguished the Fish Haven Dolomite from the overlying Laketown Dolomite by lithology and fauna.

Distribution. — In the Silver Island Mountains the Fish Haven Dolomite is well exposed on Silver Island (see pl. 1A and figs. 4, 5 and 6). It is also exposed at the head of Millard Canyon in the eastern portion of the Leppy Range.

Character and thickness. — The Fish Haven Dolomite aggregates 505 feet on Silver Island (see pl. 3).

The basal 377 feet consists of cliff-forming, light-gray mottled, fine-crystalline, medium-gray to black dolomite which weathers medium gray to blue black and contains chert nodules and stringers.

The upper 128 feet consists of interbedded maroon mottled, chert-bearing, fine-crystalline, light- to dark-gray dolomite which weathers light to medium gray; and dolomitic, tan siltstone. This unit forms a slope.

Stratigraphic relations. — The paraconformable? contact between the Fish Haven Dolomite and the underlying Eureka Quartzite is placed at the top of the last sandstone and the base of the first dolomite.

The paraconformable contact between the Fish Haven Dolomite and the overlying Laketown Dolomite is placed at the top of a slope-forming, maroon mottled, dolomite and dolomitic, tan siltstone, and at the base of a cliff-forming, medium-gray dolomite.

Paleontology. — Fossils collected by the writer from the Fish Haven Dolomite in the Silver Island Mountains were identified as follows by R. H. Waite (1958, written communication).

Unit 4—*Palaeophyllum?* sp.
Halysites sp.
Unit 6—*Palaeophyllum?* sp.
Halysites sp.
Streptelasma sp.
Favosites sp.
Unit 8—*Rhynchotrema* sp.
Halysites sp.
Streptelasma sp.
Palaeophyllum? sp.
Unit 9—*Plaesiomys* sp.
Austinella sp.
Rhynchotrema sp.
Streplelasma trilobatum

In the northern portion of Silver Island, Anderson (1957, p. 37) collected silicified brachiopods in the upper two feet of the basal three-foot unit of the Fish Haven Dolomite. This fauna was identified by Walter Sadlick as follows:

Unit 1 (?)—*Lepidocyclus* (formerly *Rhyncotrema*) *capax?*
Platystrophia trentonensis ?
Herbetella ? sp.
Hesperorthis ? sp.

Age and corrleation. — Sadlick (Anderson, 1957, p. 39) believes the fauna from unit 1 (?) is Late Ordovician in age but that further work is needed before more definite age assignments are possible.

R. H. Waite (1958, written communication) assigned a Late Ordovician age to units 4 through 9 of the Fish Haven Dolomite in the Silver Island Mountains with a definite Richmondian age for unit 9. Waite correlated the fauna of unit 9 with the Maquoketa Shale fauna described by Wang (1949). Twenhofel and others (1954, pl. 1) have correlated the Maquoketa strata with the Richmond "group" of the Cincinnatian Series. However, recent work by Gustadt (1958, p. 514-515) has shown that the type Cincinnatian Series and the Maquoketa shale form a continuous rock unit with evidence of only local absence of Eden and Maysville equivalents. Thus, it seems that unit 9 should be assigned a Cincinnatian age rather than a more definite Richmondian age.

Furthermore, Flower (1952, pp. 25-26) has stated that many genera of cephalopods long known in the presumably Richmondian Red River Formation and Bighorn Dolomite of the west have recently been identified by him in beds of late Trentonian age in the east.

J. Bridge (oral communication in Ross, 1953, p. 25) suggested that the Fish Haven Dolomite could have been in the process of deposition from late Middle through Late Ordovician time.

The Fish Haven dolomite is correlated with its type locality in southeastern Idaho based on lithology, stratigraphic position, and fauna.

The upper slope-forming 128 feet of the Fish Haven Dolomite in the Silver Island Mountains is correlated with the Floride Dolomite of the Thomas Range, Utah, as described by Staatz and Osterwald (1959, p. 21-22).

Measured section. —

Section of the Fish Haven Dolomite in NW¼NW¼ sec. 9, T. 2 N., R. 17 W. (unsurveyed).

Silurian:
Laketown Dolomite.
Paraconformity.
Ordovician:
Fish Haven Dolomite:

Unit	*Description*	*Feet*
9.	Dolomite, the lower two-thirds of unit is light- to medium-gray; fine-crystalline; occasional chert stringers in lower portion; occasional dolomitic siltstone beds in upper portion, tan; red mottling; the upper one-third of unit is dark- to medium gray; weathers tan to light gray; brown and maroon mottling; entire unit thin-bedded and platy; forms slope, fossils in lower two-thirds of unit — *Plaesiomys, Austinella, Rhynchotrema, Streptelasma trilobatum*	128
8.	Dolomite, medium- to dark-gray; fine-crystalline; contains chert in lower 25 feet and upper 10 feet; light gray mottling; faint laminated; surface weathers rough and blocky; massive; forms cliff; fossils — *Rhynchotrema, Halysites, Streptelasma, Palaeophyllum?*	95
7.	Dolomite, dark blue-gray; weathers alternately light, medium and dark gray which presents a banded appearance; fine-crystalline; laminated; thick-bedded; forms ledges	56
6.	Dolomite, medium gray; abundant chert nodules; massive; light-gray mottling; forms cliff; fossils — *Palaeophyllum?, Halysites, Streptelasma, Favosites*	91
5.	Dolomite, black; weathers blue-black; contains chert nodules in basal 10 feet, black; occasional chert stringers; massive; laminated; occasional light gray mottling; forms cliff	33
4.	Dolomite, medium gray; weathers light gray; fine-crystalline; chert nodules, light gray, weathers brown; forms ledge; fossils — *Palaeophyllum?, Halysites*	5
3.	Dolomite, black; weathers blue-black; fine-crystalline; arenaceous; chert nodules in basal 2 feet, black; thick-bedded; forms cliff; fossils — corals	39
2.	Dolomite, black; forms slope	53
1.	Dolomite, dark-gray; fine-crystalline; iron coated bands; forms ledge; fossils correlated with this unit — *Lepidocyclus capax?, Platystrophia trentonensis?, Hebertella?* sp., *Hesperorthis?*	5
	Total Fish Haven Dolomite	505

Paraconformity?
Eureka Quartzite:
Upper Sandstone member.

SILURIAN SYSTEM

In the Silver Island Mountains, the Silurian System is represented by one formation, the Laketown Dolomtie, which aggregates 1,141 feet in thickness on Silver Island.

Laketown Dolomite

History of nomenclature. — Richardson (1913, p. 410) named the Laketown Dolomite from exposures in Laketown Canyon, Randolph Quadrangle, Utah. He defined the Laketown as a massive light gray to whitish dolomite, containing lenses of calcareous sandstone with an approximate thickness of 1,000 feet. He also proposed to restrict the Laketown Dolomite to beds of Silurian age.

Distribution. — In the Silver Island Mountains, the Laketown Dolomite is well exposed on Silver Island (see pl. 1A and figs. 4, 5 and 6). The Laketown Dolomite is also exposed one mile north of Tetzlaff Peak in the eastern portion of the Leppy Range.

Character and thickness. — The Laketown Dolomite aggregates 1,141 feet on Silver Island (see pl. 3). On Crater Island, in the northern part of the Silver Island Mountains, the Laketown Dolomite thins to 439 feet in thickness modified after Anderson, 1957, p. 43-44.

The lower three units of the Laketown dolomite form a banded, marker member which aggregates 261 feet. Units 1 and 3 are medium-gray dolomites and unit 2 is a dark-gray dolomite.

In general, the upper 880 feet of Laketown Dolomite have the following lithologies: jagged slope and cliff-forming, dark blue-gray dolomite which weathers medium gray, black, tan; and contains black chert nodules and beds. The upper 591 feet contain only 54 feet of chert-bearing beds.

Stratigraphic relations. — The paraconformable contact between the Silurian Laketown Dolomite and the underlying Ordovician Fish Haven Dolomite is placed at the top of a slope-forming maroon mottled, silty dolomite which contains Richmondian fossils; and at the base of a cliff-forming, medium-gray dolomite.

The paraconformable contact between the Silurian Laketown Dolomite and the overlying Devonian Simonson Formation is placed at the top of a cliff-forming, medium-crystalline, light-gray dolomite which weathers tan; and at the base of a cliff-forming, fine-crystalline, medium-tan to gray dolomite which weathers light gray.

The highest unit of the Laketown Dolomite, as described above, has also been studied by Osmond (1954, fig. 2) and Paddock (1956, p. 65).

The thinning of the Laketown Dolomite northward in the Silver Island Mountains from 1,141 feet on Silver Island to 439 feet on Crater Island (modified after Anderson, 1957, p. 43-44) has been attributed to unconformities within the formation (Paddock, 1956, p. 65-66) and to the unconformity at the top of the formation.

Paleontology. — Fossils collected by the writer from the Laketown Dolomite on Silver Island were identified by R. H. Waite (1958, written communication).

Unit 7—*Syringaxon* sp.
aff. *Roemeria* sp.

Waite makes the following statement with regard to the last specimen.

"I have collected many corals from the Great Basin, but this form is new to me. It strongly resembles *Roemeria* from the Devonian of Europe and Australia. Not reported from America. It resembles *Cannapora* from the Silurian of the eastern U. S. but lacks the septal spines characteristic of that genus."

Unit 15—*Heliolites* sp.
Cladopora sp.

Other fossils collected by the writer from the Laketown Dolomite on Silver Island but not tied into the measured section are as follows:

Favosites sp.
Halysites sp.
Syringopora sp.
stromatoporoids

Anderson (1957, p. 43) reported the following additional fauna from the Laketown Dolomite on Silver Island which were also identified by Waite.

Howellella cf. *H. pauciplicata*
Howellella cf. *H. pahranagatensis*
Protathyris hesperalis
Rhynchotreta sp.

Age and correlation. — The Laketown Dolomite in the Silver Island Mountains is assigned a Niagaran age (Nolan, 1935, p. 18) with the possibility that its upper portion may be Upper Silurian (Waite in McFarlane, 1955, p. 24; Osmond, 1954, p. 1929).

The Laketown Dolomite is correlated with its type locality in Laketown Canyon, Randolph Quadrangle, Utah, based on lithology, stratigraphic position and fauna.

Measured section. —

Section of the Laketown Dolomite in NE¼NE¼ sec. 9 and SE¼ sec. 4, T. 2 N., R. 17 W. (unsurveyed)

Devonian:
Simonson Formation:
Lower Alternating Dolomite member.
Paraconformity.
Silurian:

Laketown Dolomite:

Unit	Description	Feet
17.	Dolomite, light-gray; weathers light tan, medium-crysatlline; massive; forms cliff	55
16.	Dolomite, medium blue-gray; weathers medium to dark gray with lateral color change in basal portion to medium to dark brown; fine-crystalline; thick bedded; weathers rough; forms ledges and slopes in basal 137 feet and forms cliff in upper 99 feet	236
15.	Dolomite, blue-gray; weathers dark gray; black chert nodules and stringers; light gray mottling; forms cliff; fossils — *Heliolites, Cladopora*	18
14.	Dolomite, medium blue-gray; weathers medium to dark tan gray; thin (less than 2 inches) black chert beds which are discontinuous; arenaceous laminations; silicified; forms cliff; fossils — crinoid hash	28
13.	Dolomite, as unit 11 except lower one-half forms slope and upper one-half forms cliff	66
12.	Sandstone and dolomite, interbedded; sandstone, light-tan; weathers orange brown; fine-grained; calcareous; dolomite beds 6 inches to 2 feet in thickness, medium-gray; weathers medium gray; fine crystalline; upper 4 feet of unit is siltstone; calcareous; platy; with maroon liesegang rings; entire unit forms slope	34
11.	Dolomite, blue-gray, weathers medium gray to tan; fine-crystalline, ½-inch black chert beds which are discontinuous; platy; forms ledge	8
10.	Dolomite, blue-gray, weathers medium tan to gray; fine-crystalline; forms cliff	62
9.	Dolomite, dark blue-gray, weathers dark gray to tan, forms slope except for upper 13 feet which forms ledge	84
8.	Dolomite, as unit 8 except forms slope	59
7.	Dolomite, dark blue-gray; weathers medium gray to tan; chert nodules, and lenses, black, 2 inches in thickness and 3 feet in length; surface weathers rough; forms cliff; fossils — *Syringaxon;* aff. *Roemeria*	102
6.	Dolomite, dark blue-gray; weathers black; fine-crystalline; abundant chert nodules and beds weather black and tan; forms slope	94
5.	Dolomite, tan; weathers tan-brown; chert beds, light tan, weathers orange-brown, sharp contact with upper unit; forms jagged slope	25
4.	Dolomite, black; irregular chert nodules, black; weathers orange brown, forms jagged slope	9
3.	Dolomite, medium to light blue-gray; weathers medium brown and gray with overall brown appearance; medium-crystalline; "sugary texture"; forms slope	103
2.	Dolomite, dark blue-gray, weathers dark gray; fine-crystalline, laminated; vugs filled with mineral dolomite, contact gradational with upper unit; forms cliff; fossils — 1-foot coral zone 5 feet from top of unit	85
1.	Dolomite, medium-gray, weathers light to medium gray; fine-crystalline; chert present in upper 8 to 10 feet; very sharp contact with upper unit; forms cliff	73
	Total Laketown Dolomite	1,141

Paraconformity.

Ordovician:

Fish Haven Dolomite.

DEVONIAN SYSTEM

The Devonian System in the Silver Island Mountains is represented by three formations which aggregate a maximum thickness of 3,924 feet.

Simonson Formation

History of nomenclature. — Nolan (1935, p. 19) named the Simonson Dolomite of Devonian age for exposures in Simonson Canyon on the west side of the Deep Creek Mountains, Utah.

The Simonson at the type locality is a dark- to medium-gray dolomite in which the individual grains are large enough to be distinguished by the unaided eye (Nolan, 1935, p. 19). The presence of a fine lamination is the most striking feature of the formation (Nolan, 1935, p. 19).

Osmond (1954, p. 1931) made a regional study of the Simonson Dolomite in east-central Nevada and west-central Utah. He divided the Simonson Dolomite into four members as follows: the lowest member is a coarse-crystalline, tan dolomite which forms a massive cliff; above this is a sequence of alternating light-gray and dark-brown dolomite beds which have a striped appearance because of their contrasting colors; the next member is a cliff-forming, massive, brown dolomite; and the highest member is a sequence of altrnating dolomites and limestones.

The Simonson Formation on Silver Island consists of a lower alternating dolomite member and an upper alternating interbedded limestone and dolomite member.

Distribution. — Excellent exposures of the Simonson Formation are present throughout the central portion of Silver Island and in the northern portion of Crater Island (see pls. 1A, 2A, and figs. 7, 8). The Simonson is also exposed one mile north of Wendover in the Leppy Range.

Character and thickness. — The lower alternating dolomite member of the Simonson Formation in the Silver Island Mountains aggregates 336 feet (see pl. 3). This member is one of the most striking rock units of the Paleozoic section (see figs. 7 and 8). The lower alternating dolomite member consists of alternating shades of gray, white, tan, black, and buff dolomites. The dolomites are fine-crystalline and laminated. The upper alternating interbedded limestone and dolomite member aggregates 934 feet (see pl. 3).

The percentage of dolomite rock in the upper member increases from 10 per cent in the lower one-half to 60 per cent in the upper one-half.

The upper member consists of ledge-to cliff-forming, fine-crystalline, dark-gray to black limestone which is often mottled orange, tan, brown, gray, and maroon, interbedded with alternating dolomites of various shades of gray, white, tan, black, and buff which are fine-crystalline, laminated and form ledges.

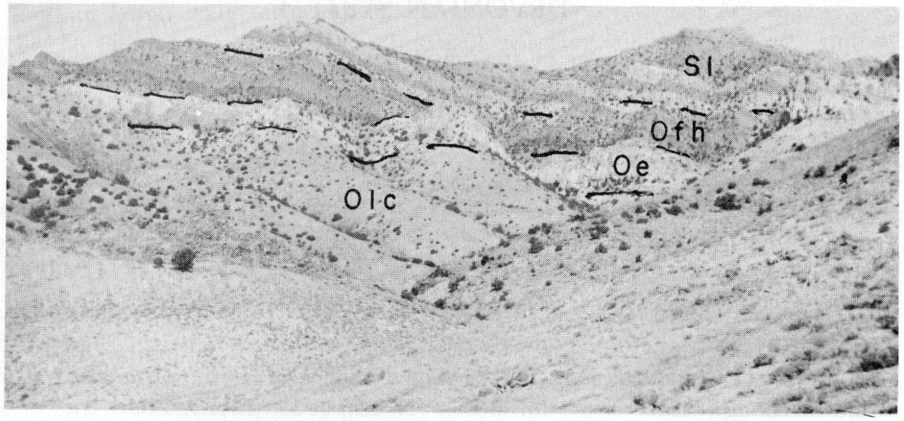


Fig. 6. View looking northwest, Campbell Peak on right. Olc, Lehman Formation, Tongue of Swan Peak Quartzite, and Crystal Peak Dolomite undifferentiated; Oe, Eureka Quartzite; Ofh, Fish Haven Dolomite; Sl, Laketown Dolomite.

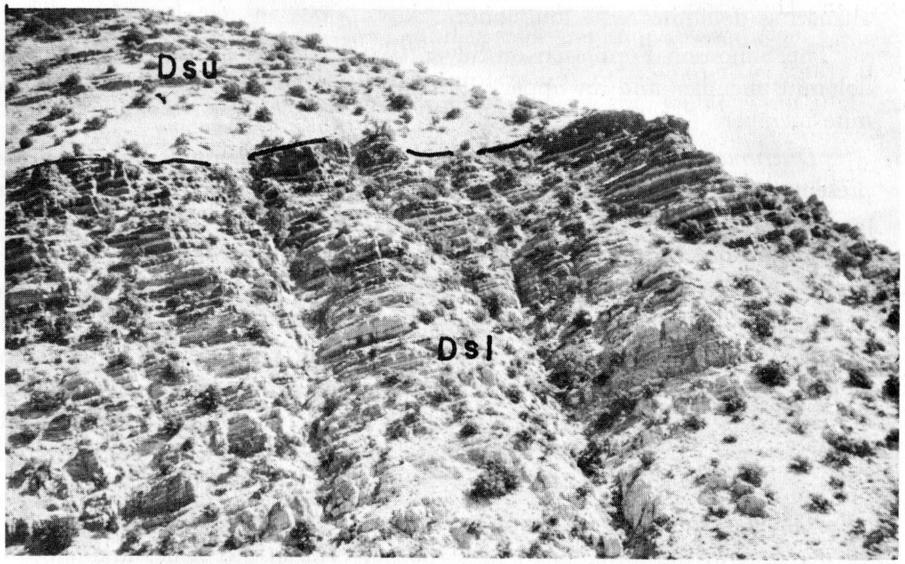


Fig. 7. View looking north near Cave Canyon on Silver Island. Dsl, Lower Alternating Dolomite member of Simonson Formation; Dsu, Upper interbedded limestone and dolomite member of Simonson Formation.

The mottling of the limestones described above has been noted in similar limestones of the Simonson by Osmond (1956, p. 38). Osmond (1956, p. 40) states:

> "Tentatively, mottling is attributed to semi-restricted shelf environments in which a fine textured calcareous sediment containing organic residues is buried at a moderate rate."

Osmond (1954, p. 1941) makes the following observation with regard to the irregular contact surfaces between some of the dolomite beds within the Simonson Formation (see fig. 9):

> "The undulating upper surfaces reflect the plastic nature of these muds during the deposition of superjacent strata. Small irregularities were accentuated by slightly differential loading. Thus, the higher places rose still higher during the deposition of the brown laminae above."

Stratigraphic relations. — The tan coarse-crystalline dolomite member of the Simonson Formation as described by Osmond (1954, p. 1932) was not observed in the Silver Island Mountains.

The paraconformable contact between the Devonian Simonson Formation and the underlying Silurian Laketown is placed at the top of a cliff-forming, medium-crystalline, light-gray dolomite which weathers tan, and at the base of a fine-crystalline, medium-tan to gray dolomite which weathers light gray. This light gray dolomite is the base of the lower alternating dolomite member.

The contact between the Simonson Formation and the overlying Guilmette Limestone is placed at the top of the last dolomite in the upper alternating interbedded limestone and dolomite member, and at the base of a continuous sequence of cliff-forming, fine-crystalline, black limestones.

With regard to the upper contact of the Simonson Formation, Osmond (1954, p. 1946) states:

> "In east-central Nevada and adjacent Utah the most easily recognized contact is where the dolomite section changes upward into one predominantly of limestone. The Simonson formation, to be most applicable in the field and thus fulfill the requirements of formational rank, should have its upper contact at this lithologic change. The interfacies nature of this contact must be kept in mind."

Paleontology. — Waite (1958, written communication) identified the following fossils from the Simonson Formation.

The lower alternating dolomite member yielded *Atrypa* cf. *A. montanensis.*

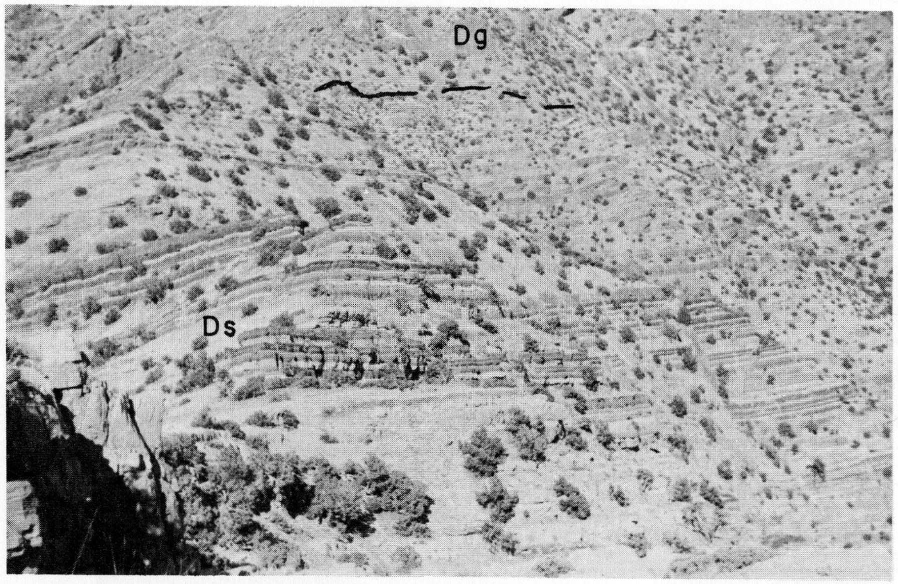


Fig. 8. View looking north near Cave Canyon on Silver Island. Ds, Simonson Formation; Dg, Guilmette Limestone.

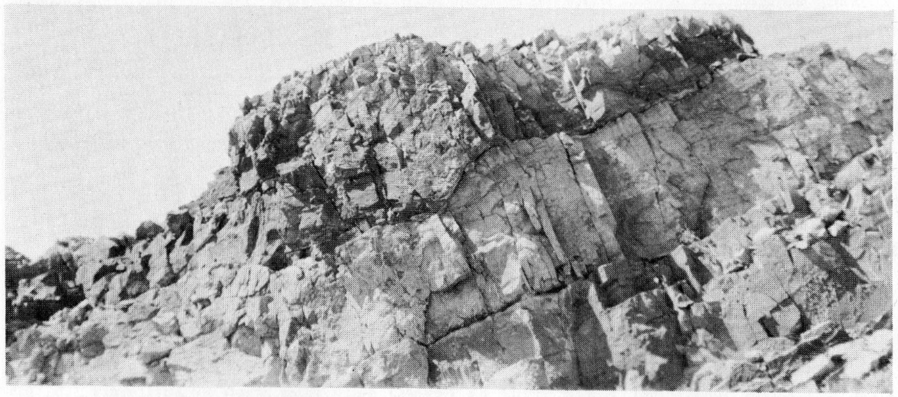


Fig. 9. Uneven surface between light and dark gray beds of the Simonson Formation, central Crater Island (Anderson, 1957).

The upper member yielded:

Unit 60—*Hexagonaria* sp.

Unit 122—*Coenites* (Cladopora of Hall, 1851)

stromatoporoid (see fig. 10) biostrome (8 feet in thickness)

Stringocephalus sp.

The writer identified the following additional fossils from the base of the upper member of the Simonson formation.

Unit 59—*Martinia maia*

Proetus nevadae

?*Schuchertella haguei*

Atrypa or *Spinatrypa* sp.

The following fossils were collected from the upper member of the Simonson Formation. The first two specimens were identified by Waite and the remainder by the writer.

Cystiphyllum sp.
encrusting *Aulopora* sp.
Atrypa montanensis
Martinia maia
Breviconic? nautiloid
Paracyclas? sp.
Schizodus? sp.
Nucula sp.
Edmondia? sp.

Age and correlation. — The Simonson Formation is assigned a Middle Devonian age in the Silver Island Mountains due to the presence of *Hexagonaria* in unit 60 and *Stringocephalus* in Unit 122.

The lower alternating dolomite member of the Simonson Formation in the Silver Island Mountains is correlated with the lower alternating member of Osmond (1954, p. 1932) based on lithology and stratigraphic position.

The upper alternating interbedded limestone and dolomite member is correlated with the upper alternating member of Osmond (1954, p. 1945) based on lithology and fauna.

Normally in east-central Nevada and west-central Utah, the upper alternating member lies between the brown cliff member of the Simonson Formation and the black limestone cliffs of the Guilmette Limestone (Osmond, 1954). However, in the Silver Island Mountains the brown cliff member is not present. The lower portion of the upper alternating interbedded limestone and dolomite member might be a facies of the brown cliff member (which is a dolomite biostrome). This possibility has been considered by Osmond (1954, p. 1946) who states:

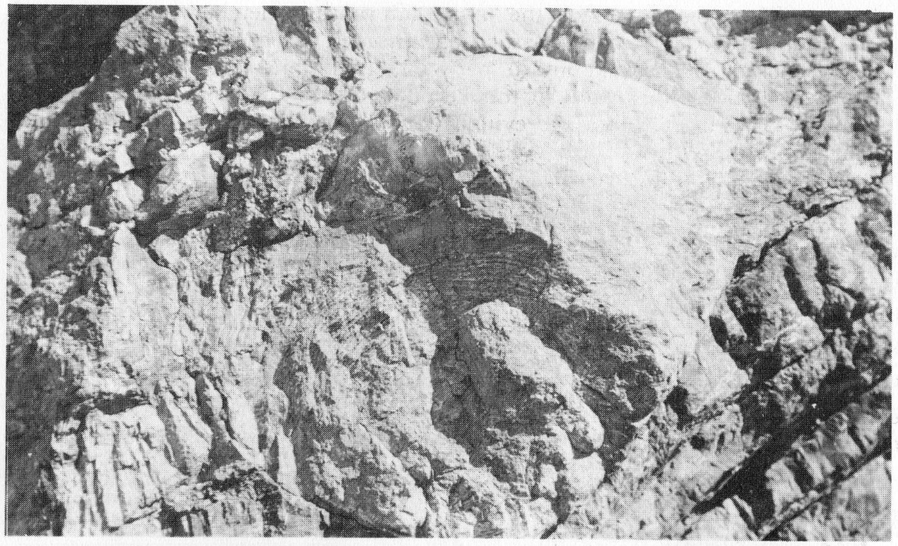


Fig. 10. Large stromatoporoid in the basal Simonson Formation a few feet above the Laketown-Simonson contact on northwest Silver Island. This specimen is about 2.5 feet in diameter (Anderson, 1957).

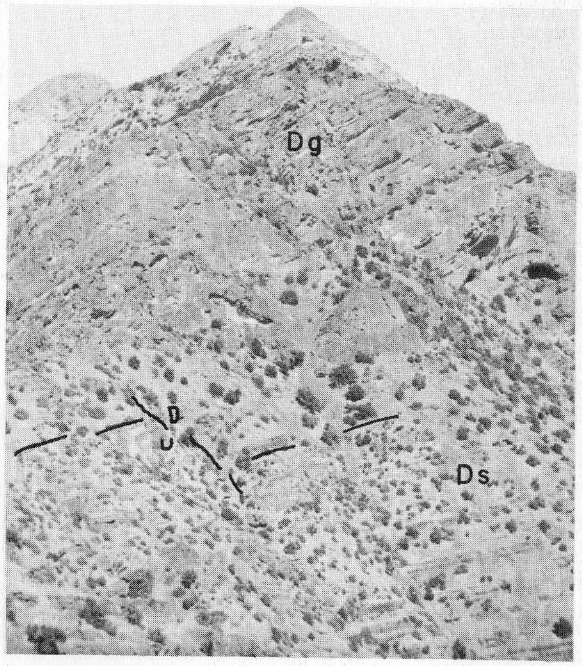


Fig. 11. View looking north at Silver Peak. Ds, Simonson Formation; Dg, Guilmette Limestone.

"The possibility that the upper alternating member is a facies of the brown cliff member, such as fore-reef or back-reef, has been considered. Such relationship between "reef" and overlying strata has been well illustrated in the Permian of West Texas (Newell et al., 1953, Fig. 53), but the evidence in the base does not prove this relationship with the brown cliff member."

Osmond (1954, p. 1951) reported *Hexagonaria*? from the brown cliff member (dolomite biostrome) in the Southern Egan Range, Nevada. Approximately 30 feet above the base of the upper alternating interbedded limestone and dolomite member in the Silver Island Mountains is a limestone biostrome which contains *Hexagonaria*. This biostrome may represent an undolomitized section of the brown cliff member. If this correlation is correct then the lower portion of the upper alternating interbedded limestone and dolomite member of the Simonson Formation in the Silver Island Mountains is correlative with the brown cliff member of Osmond (1954).

The Simonson Formation is also correlated with the Nevada Formation (Osmond, 1954, fig. 26).

Measured section. —

Section of the Simonson Formation in E½ sec. 4, T. 2 N., R. 17 W., (unsurveyed)

Devonian:

Guilmette Limestone.

Simonson Formation:

Upper Alternating Interbedded Limestone and Dolomite member:

Unit	*Description*	*Feet*
134.	Dolomite, black; weathers tan-brown; fine-crystalline, forms ledges	11
133.	Dolomite, black; weathers dark gray and black; fine-crystalline; calcareous; banded appearance; forms ledges and slopes	35
132.	Dolomite, light tan-gray; fine-crystalline; calcareous; forms slope	58
131.	Limestone, black; fine-crystalline; laminated; calcite stringers; massive; forms cliff; fossils — *Coenites* 29 feet above base	54
130.	Dolomite, medium- to dark-gray, fine-crystalline calcareous; forms slope	72½
129.	Dolomite, black; fine-crystalline; calcareous; laminated; forms ledge	10
128.	Dolomite, light-gray to tan; fine-crystalline; forms slope and jagged ledges	12
127.	Dolomite, dark-gray; weathers light gray; cryptocrystalline; banded appearance	2
126.	Limestone, black; fine-crystalline	3
125.	Dolomite, dark-gray; weathers light to dark gray, calcareous; fine-crystalline	3
124.	Dolomite, black, fine-crystalline; silty	5
123.	Limestone, dark-gray; weathers medium gray; fine-crystalline fossils — small stronmatoporoids	3

122.	Limestone, black; fine-crystalline; forms cliff; fossils — *Coenites* (= Cladopora of Hall, 1851), 8-foot biostrome of stromatoporoids ("football size") 28 feet above the base, *Stringocephalus* 50 feet above base	62
121.	Dolomite, dark-gray, weathers light gray; fine-crystalline; calcareous; forms ledge	6
120.	Limestone, black, upper 1-foot alternating from light- to dark-gray; fine-crystalline; thin chert seams; forms ledge	4
119.	Dolomite, medium-gray; weathers light gray to tan-gray; fine-crystalline	1
118.	Limestone, black, fine-crystalilne, light gray mottling; laminated; forms ledge	6
117.	Dolomite and limestone; dolomite, dark-gray to black; fine-crystalline; silty; calcareous; "zebra banding" filled with mineral dolomite; limestone, black; fine-crystalline	5
116.	Covered, forms slope	31½
115.	Dolomite, light-gray, fine-crystalline	1
114.	Dolomite, dark-gray; fine-crystalline; calcareous; forms slope	3
113.	Limestone, orange-tan; fine-crystalline; argillaceous	1
112.	Dolomite, black; fine-crystalline; calcareous	1
111.	Dolomite, dark gray; fine-crystalline; calcareous; silty; calcite veins and stringers, "zebra banding" filled with mineral dolomite; forms cliff	10
110.	Limestone, black; fine-crystalline; forms ledge	2
109.	Dolomite, light-gray; fine-crystalline; forms slope	2
108.	Limestone, black; fine-crystalline; laminated	2
107.	Dolomite, medium-tan; weathers light tan; fine-crystalline, forms slope	8½
106.	Limestone, black; fine-crystalline; orange-maroon mottling forms ledge	2
105.	Dolomite, tan; weathers light gray; fine-crystalline; calcareous; forms slope	2
104.	Dolomite, medium- to dark-gray; fine-crystalline; calcareous; laminated; forms slope	1
103.	Limestone, black, weathers medium gray to black; fine-crystalline; dolomitic, vugs filled with mineral dolomite; forms ledge	2
102.	Dolomite, medium-gray, weathers medium to light gray, fine-crystalline; laminated; forms slope	2
101.	Limestone, black; fine-crystalline; forms ledge	4
100.	Dolomite, light-gray; fine-crystalline; calcareous	2
99.	Dolomite, buff to tan; fine-crystalline; calcareous; platy, forms slope	2
98.	Limestone, dark-gray; fine-crystalline	1
97.	Dolomite, orange-tan, fine-crystalline; vugs filled with mineral dolomite	1
96.	Limestone, black; fine-crystalline, forms ledge	5
95.	Dolomite, tan; weathers light gray; fine-crystalline	2
94.	Limestone, black; fine-crystalline; occasional orange-brown mottling	1
93.	Dolomite, tan; fine-crystalline; forms slope	2
92.	Limestone, black, fine-crystalline; laminated	1
91.	Dolomite, medium-tan; weathers light tan; fine-crystalline	1
90.	Dolomite, dark-gray, weathers light to dark gray; fine-crystalline; calcareous; laminated at base; forms ledge	4
	-ly laminated maroon mottling; forms slope	28

89.	Limestone, black; fine-crystalline; silty; thin-bedded, platy fine-	
88.	Limestone, black; weathers black to medium gray; fine-crystalline; forms cliff	7
87.	Limestone, medium-gray, fine-crystalline; laminated; light-gray mottling in upper 3 feet; forms cliff	10
86.	Dolomite, dark-gray, weathers light gray; fine crystalline; faintly laminated	2
85.	Cov.red, forms slope	7
84.	Limestone, black; fine-crystalline; massive; brown and maroon mottling in upper 10 feet; forms cliff; fossils — brachiopods (1¼ inches in length) in upper 10 feet	47
83.	Dolomite, tan, weathers light gray; fine-crystalline, calcareous; very sharp contact with unit above	6
82.	Limestone, black; fine-crystalline; dolomitic; laminated	7
81.	Dolomite, medium-gray to black; weathers light gray to light tan fine-crystalline; calcareous	15
80.	Limestone, black; fine-crystalline; faintly laminated	7
79.	Dolomite, dark gray; weathers light gray; fine-crystalline; calcareous; gray mottling	7
78.	Limestone, black; fine-crystalline; platy; maroon mottling	5
77.	Dolomite, medium-gray; weathers tan to white, fine-crystalline; calcareous	1
76.	Limestone, black; fine-crystalline; 5 feet below top is a 1-foot gray dolomite bed, upper 5 feet laminated; weathers blocky; massive; forms cliff	25
75.	Dolomite, dark-gray; weathers tan; fine-crystalline; calcareous	1
74.	Limestone, black, fine-crystalline; lower 30 feet is massive and upper 16 feet is very platy and laminated; forms cliff	46
73.	Dolomite, black, fine-crystalline; calcareous; laminated	5
72.	Limestone, black; fine-crystalline; upper 25 feet laminated; forms slope; fossils — stromatoporoids and calcified brachiopods	58
71.	Dolomite, black; weathers tan; fine-crystalline; calcareous	1
70.	Limestone, black; fine-crystalline	2
69.	Dolomite, dark-gray weathers light gray, fine-crystalline; calcareous	1
68.	Limestone, black; fine-crystalline, dolomitic near base; laminated; forms cliff	8
67.	Dolomite, medium-gray, weathers light gray; fine-crystalline; calcareous	3
66.	Limestone, black, fine-crystalline; laminated; forms slope	13
65.	Dolomite, black; weathers light gray; fine-crystalline; calcareous; laminated	1
64.	Limestone, black, fine-crystalline thin-bedded, platy; calcite stringers; brown mottling locally; 10′ above base is a 1-foot bed of dolomite, tan, weathers light gray, forms cliff	30
63.	Limestone, dark-gray; weathers black to tan; fine-crystalline; laminated	8
62.	Dolomite, dark-gray, weathers light gray, fine-crystalline; calcareous; faintly laminated	1
61.	Limestone and dolomite; limestone, black; fine-crystalline dolomitic; occasionally laminated; dolomite, dark-gray weathers buff to tan; calcareous; entire unit thick-bedded; forms slope	94
60.	Limestone, black; fine-crystalline; platy purple-maroon mottling near base, iron coated patches, irregular bedding planes; fossil hash near base, F281, *Stringocephalus?* and stromatoporoid bioherm at top of cliff, forms cliff; fossils — *Hexagonaria, stromatoporoid and Stringocephalus?* biostrome near top of unit	20

59.	Limestone, dark-gray to black; fine-crystalline; pink to orange-tan mottling; fossil hash in upper one-half of unit; forms slope; fossils — *Martinia maia, Proetus nevadae, ?Schuchertella haguei, Atrypa* or *Spinotrypa*	17
	Total Upper Alternating Interbedded Limestone and Dolomite member	934

Lower Alternating Dolomite Member:

Unit	*Description*	*Feet*
58.	Dolomite, black and tan; fine-crystalline; light- to medium-gray and pink mottling; platy; medium-bedded; forms slopes and ledges	24
57.	Dolomite, black; fine-crystalline; upper 4 feet contains maroon mottling; fossils — gastropods and brachiopods	19
56.	Doolmite, light-gray; fine-crystalline; laminated	2
55.	Dolomite, black, fine-crystalline; silty; laminated	5
54.	Dolomite, medium- to dark-gray; weathers light gray; fine-crystalline	2
53.	Dolomite, dark-gray to black; weathers dark gray; fine-crystalline; silty; laminated	4
52.	Dolomite, medium- to dark-gray; weathers light gray; fine-crystalline	2
51.	Dolomite, black; fine-crystaline; laminated; vugs filled with mineral dolomite; medium gray mottling	8
50.	Dolomite, medium-gray, weathers light gray; fine-crystalline; laminated	3
49.	Dolomite, black; fine-crystalline; silty; laminated	7
48.	Dolomite, tan-gray; weathers light gray to white; fine-crystalline	1
47.	Dolomite, black; fine-crystalline; silty; laminated	3
46.	Dolomite, medium-gray; weathers light gray to white; fine-crystalline	3
45.	Dolomite, black; medium-crystalline; silty to sandy	8
44.	Dolomite, black, fine-crystalline; vugs filled with mineral dolomite	6
43.	Dolomite, medium-gray; weathers light gray; fine-crystalline; laminated	5
42.	Dolomite, dark-gray to black; fine-crystalline; silty; laminated	4
41.	Dolomite, light-gray, fine-crystalline	3
40.	Dolomite, dark-gray, weathers medium gray; calcareous; silty; laminated; vugs filled with mineral dolomite	6
39.	Dolomite, black; fine-crystalline; laminated	2
38.	Dolomite, medium- to dark-gray; weathers light gray; fine-crystalline; calcareous; pink-brown mottling	11
37.	Dolomite, medium-gray; weathers light and dark gray; calcareous; fine-crystalline; light- and dark-gray mottling; laminated; banded; vugs filled with mineral dolomite; upper two feet are calcareous	8
36.	Dolomite, medium-to dark-gray; weathers light gray; fine-crystalline; forms slope	3
35.	Dolomite, black; fine-crystalline; silty; laminated	4
34.	Dolomite, medium-bray; weathers light gray; fine-crystalline	1
33.	Dolomite, black; fine-crystalline; silty; laminated	½
32.	Dolomite, dark-gray; weathers light gray; fine-crystalline; laminated	1

31.	Dolomite, black, fine-crystalline; silty; laminated	5
30.	Dolomite, light-gray; fine-crystalline; laminated	1
29.	Dolomite, black; fine-crystalline; silty; laminated	5
28.	Dolomite, medium-gray; weathers light to medium gray; fine-crystalline; silty; laminated	2
27.	Dolomite, dark-gray, fine-crystalline; silty; laminated	2
26.	Dolomite, tan-gray; weathers light gray fine-crystalline	2
25.	Dolomite, dark tan-gray; weathers buff to tan; fine-crystalline	1
24.	Dolomite, tan-gray; weathers light gray fine-crystalline	6
23.	Dolomite, dark-gray; weathers light gray to white; fine-crystalline; faintly laminated	1
22.	Dolomite, medium-gray; weathers tan and medium gray; fine-crystalline; sandy; laminated	14
21.	Dolomite, medium-gray, fine-crystalline; platy	2
20.	Dolomite, dark-gray; weathers light gray; fine-crystalline; laminated	5
19.	Dolomite, black; fine-crystalline; laminated; uneven surface at base	1
18.	Dolomite, tan-gray; weathers white; fine-crystalline	1
17.	Dolomite, medium-gray; fine-crystalline; sandy; calcareous; white specks laminated	2
16.	Dolomite, dark-gray, weathers medium gray; fine-crystalline; silty; laminated	½
15.	Dolomite, tan-gray; weathers white; fine-crystalline	3
14.	Dolomite, light- to medium-gray; weathers light gray; fine-crystalline; vugs and seams filled with mineral dolomite	4
13.	Dolomite, medium-gray; fine-crystalline	1
12.	Dolomite, medium-gray; weathers light gray; fine-crystalline; laminated	2½
11.	Dolomite, medium-gray; fine-crystalline; laminated	5
10.	Dolomite, medium-gray; weathers light gray; fine-crystalline	3
9.	Dolomite, dark-gray; weathers medium gray; fine-crystalline	3
8.	Dolomite, black; weathers gray-black; fine-crystalline; thinly laminated	1
7.	Dolomite, light- gray; fine-crystalline	3
6.	Dolomite, medium-gray; fine-crystalline	3
5.	Dolomite, black; silty; laminated	2
4.	Dolomite, light- to medium-gray; weathers tan and gray; fine-crystalline; sandy; finely laminated; forms cliff	79
3.	Dolomite, medium-tan; weathers white; fine-crystalline occasional pink mottling; forms ledge	3
2.	Dolomite, medium-gray; weathers light gray; fine-crystalline; laminated vugs filled with mineral dolomite; forms ledge	3
1.	Dolomite, medium-tan to gray; weathers light gray; fine-crystalline; forms cliff	25
	Total Lower Alternating Dolomite member	336
	Total Simonson Formation	1,270

Paraconformity.

Silurian:

Laketown Dolomite.

Guilmette Limestone

History of nomenclature. — Nolan (1935, p. 20) named the Guilmette Formation after exposures in Guilmette Gulch on the west side of the Deep Creek Mountains, Gold Hill, Utah. Nolan (1935, p. 20) described the Guilmette Formation as follows:

> "The Guilmette formation is composed chiefly of dolomite but contains also some thick limestone beds and several lenticular sandstones. The dolomite for the most part differs in character from those found in the Simonson dolomite . . . The most abundant variety is a fine-grained dolomite, dark to medium gray on fresh fracture and weathering to lighter shades of gray . . . Less abundant but far more striking in character is a dark dolomite filled with fragments of tubular corals."
>
> "The limestones . . . are massively bedded, dense rocks that are light brownish gray on fresh fracture but weather to shades of bluish gray. The sandstone beds forms a comparatively small portion of the formation, but the brownish color they assume on weathering makes them conspicuous."

Since the Guilmette Formation is predominantly limestone in the Silver Island Mountains it will be referred to as the Guilmette Limestone.

Distribution. — The Guilmette Limestone is well exposed in the northern portion of Silver Island, in Crater Island, and in the eastern portion of the Leppy Range (see pl. 1A).

Character and thickness. — A total thickness of 2,229 feet of Guilmette Limestone was measured and described (see pl. 3 and fig. 11).

Black limestones predominate in the lower 1,340 feet of the formation, whereas medium-gray limestones which weather light to medium gray predominate in the upper 890 feet of the formation. A shaly, calcareous, argillaceous, arenaceous dolomite is present from 300 to 350 feet below the top of the Guilmette Limestone on Silver Island.

The youngest unit of the Guilmette Limestone on Silver Island is a medium-gray limestone which weathers light to medium gray and is arenaceous in the upper portion. Northward this interval changes into a predominantly calcareous, quartzose sandstone.

In the northeastern portion of Silver Island near the head of the Silver Island Canyon is a section in the upper Guilmette Limestone which has not been described in the previous paragraphs. The lower part of the section consists of approximately 150 feet of shaly, brown quartzite and shaly, calcareous, brown siltstone. The middle part of the section consists of approximately 30 feet of black limestone and the upper part of approximately 25 feet of shaly, maroon, purple, brown siltstone. This section is believed to be overlain by approximately 75 feet of medium- to dark-gray Guilmette Limestone which in turn is overlain unconformably by the Mississippian Joana Limestone. The locality in which this section is exposed is faulted and the exact stratgraphic relations of this section with the measured section are not known. However, the writer believes it is either correlative with unit 20 or a stratigraphically higher unit than any described in the measured section.

An 8-foot quartzite unit which weathers orange-brown is exposed in the upper portion of the Guilmette Limestone at Wendover, Utah, in the Leppy Range.

Stratigraphic relations. — The contact between the Guilmette and the underlying Simonson Formation is placed at the top of the last dolomite in the upper alternating interbedded dolomite and limestone member, and at the base of a continuous sequence of cliff-forming, fine-crystalline, black limestones.

The Devonian Guilmette Limestone is overlain with angular unconformity by the Mississippian Joana Limestone on Silver Island. A karst topography may have developed upon the Guilmette Limestone prior to the deposition of the Joana Limestone (see fig. 12). On Silver Island, the unconformable contact between the Guilmette and the Joana is placed at the top of a medium-gray limestone which has a facies change northward into a predominantly calcareous, quartzose sandstone, and at the base of a black limestone which contains Mississippian fossils.

In A-1 Canyon, in the Leppy Range, the Devonian Guilmette Limestone is conformably overlain by the Devonian Pilot Shale. This contact is placed at the top of a massive, medium-gray limestone, and at the base of a slope-forming, fissile to platy, black siltstone which weathers buff, orange and tan.

Paleontology. — R. H. Waite (1958, written communication) identified the following corals from the Guilmette Limestone of the Silver Island Mountains.

Unit 10—*Coenites* sp.

Unit 18—*Syringopora* sp.
Synaptophyllum sp.

E. L. Yochelson (1958, written communication) identified a gastropod steinkern, indet. (cf. *Platyostoma*) from Unit 10.

The writer identified the following fossils from the Guilmette Limestone.

Unit 6—*Atrypa nevadana*
Tenticospirifer utahensis
Atrypa missouriensis

Unit 18—*Stringocephalus* sp.
stromatoporoids
Euryzone? sp.

The following fossils were found in a number of units in the Guilmette Limestone:

Stringocephalus sp.
Stromatoporoids
Coenites sp.

Sadlick (1959, oral communication) pointed out to the writer an orthocone bed at the top of unit 21.

The shaly siltstone unit at the head of Silver Island Canyon yielded a brachiopod and coral fauna. Sadlick studied the collection and states the following with regard to the brachiopods:

> "The specimens belong to the superfamily Atrypacea and are not younger than Frasnian (early Late Devonian). The genus *Atrypa* seems to have become extinct at the end of Frasnian time."

Age and correlation. — The Guilmette Limestone on Silver Peak, with the exception of the upper 350 feet, is assigned a Middle Devonian age based on the presence of *Stringocephalus.* However, the upper portion of the Guilmette on Silver Peak and in A-1 Canyon in the Leppy Range is probably Late Devonian in age. This conclusion is based on correlating the Guilmette Limestone of the Silver Island Mountains with the Guilmette Formation of the Newfoundland Mountains. In the Newfoundland Mountains the Guilmette contains a Late Devonian fauna in its upper part (Paddock, 1956, p. 46). The disparity in thickness between the Guilmette Limestone in the Silver Island Mountains and in the Newfoundland Mountains is mainly attributed to a disagreement between the writer and Paddock as to the position of the contact between the Guilmette Limestone and the underlying Simonson Formation.

The lower and middle portions of the Guilmette Limestone in the Silver Island Mountains are correlated with its type locality at Gold Hill, Utah, based on stratigraphic position and fauna. The upper portion of the Guilmette Limestone, which is conformably overlain by the Pilot Shale in the Leppy Range, is believed to be younger than any Guilmette exposed at Gold Hill. This is due to the unconformity at the top of the Guilmette at Gold Hill which appears to have removed any Upper Devonian Guilmette (Nolan, 1935, p. 22).

The shaly siltstone unit of the Guilmette Limestone exposed at the head of Silver Island Canyon is tentatively correlated with the Saddle member (Paddock, 1956, p. 45) of the Guilmette Formation in the Newfoundland Mountains, Utah, based on lithology and stratigraphic position. The Saddle member is assigned a Late Devonian age by Paddock (1956, p. 15).

The quartzite unit of the Guilmette Limestone, in the Leppy Range near Wendover, is probably a lithic correlative of a portion of the Stansbury Formation.

The Guilmette Limestone is also correlated with the upper portion of the Jefferson Formation (Brooks, 1954) and is the time equivalent of the combined upper portion of the Nevada Formation and Devils Gate Formation (Merriam, 1940, p. 69-70; and Paddock, 1956, p. 46-47).

Measured section. —

Section of the Simonson Formation in NE1/4 sec. 4, T. 2 N., R. 17 W.; and SE1/4 sec. 33, T. 3 N., R. 17 W. (unsurveyed)

Mississippian:
Joana Limestone.
Angular Unconformity.
Devonian:
Guilmette Limestone:

Unit	*Description*	*Feet*
21.	Limestone, medium-gray, weathers light to medium gray; fine-crystalline; unit facies northward into a predominantly calcareous, quartzose sandstone; massive; forms cliff	305
20.	Dolomite, dark-gray; fine-grained; arenaceous, argillaceous; weathers orange to buff; platy; forms slope	53½
19.	Limestone, medium-gray; fine-crystalline; forms slope; fossils — *Stringocephalus* and *stromatoporoids*	20
18.	Limestone, black; fine-crystalline; massive; forms rounded-cliff; fossils — 116 feet above base are *Syringopora, Synaptophyllum and Euryzone?;* 175 feet above base is a 3-foot zone of *Stringocephalus;* upper 2 feet of unit consists of stromatoporoids	200
17.	Limestone, medium- to light-gray; weathers white to light gray; fine-crystalline; massive; forms ledges; fossil — *Stringocephalus near base*	310
16.	Limestone, black; fine-crystalline; maroon mottling; orange-brown and tan color bands; forms slope	91½
15.	Limestone, black; fine-crystalline; massive; calcite stringers; fossiliferous; forms cliff	172
14.	Limestone, as unit 10, except forms slope and cliff	103½
13.	Limestone, tan; weathers orange tan; fine-crystalline; ledge	5
12.	Limestone, as unit 10	221
11.	Limestone, medium-gray to tan; weathers buff to tan; fine-crystalline; platy; forms ledge	4
10.	Limestone, black; weathers medium gray to black; fine-crystalline; massive forms cliff; weathers rough; fossils — *Coenites* at 200 feet above the base and at top; biostrome of stromatoporoids between 200 to 250 feet above base, cf. *Platyostoma*	420
9.	Limestone, black; fine-crystalline; massive ;forms cliff; fossils — bioherm of stromatoporoids between 50 to 80 feet above base	98
8.	Limestone, black; fine-crystalline; upper 5 feet fossiliferous; forms slope	39
7.	Limestone, black; fine-crystalline; banded; orange-brown mottling	3
6.	Limestone, dark-gray to black; fine-crystalline; maroon and tan mottling; very fossiliferous; forms slopes and cliffs; fossils — *Atrypa nevadana, Tenticospirifer utahensis, Atrypa missouriensis* in basal 10 feet of unit	126½

Fig. 12. View looking east at dip slope immediately northwest of Silver Peak. Dg, Guilmette Limestone; Mj, Joana Limestone. Arrows point to karst topography developed on Guilmette beneath Joana (photograph by Walter Sadlick).

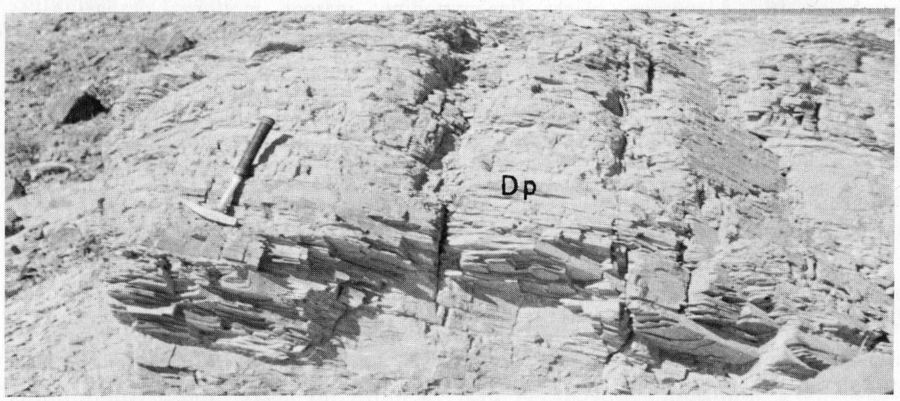


Fig. 13. View looking west in A-1 Canyon, western portion of Leppy Range. Upper part of Pilot Shale.

5.	Limestone, black; fine-crystalline; argillaceous; maroon, red and tan mottling; platy; forms slope	12
4.	Limestone, very black; very fine-crystalline; platy; weathers rough irregular bedding planes; forms ledges	18
3.	Limestone, light-tan to medium-gray; fine-crystalline; calcite stringers, forms ledge	3
2.	Limestone, black; fine-crystalline; forms cliff	21
1.	Limestone, black; fine-crystalline; gray mottling; forms cliff	3
	Total Guilmette Limestone	2,229

Simonson Formation:

Upper Alternating Interbedded Limestone and Dolomite member.

Pilot Shale

History of nomenclature. — Hague (1892, p. 68-69) defined the White Pine Shale in the White Pine Mountains, Nevada. Lawson (1906, p. 296) correlated a sequence of rocks which lie between the Nevada Limestone (unrestricted), and the Ely Limestone (unrestricted) at Ely, Nevada, with the White Pine Shale. This sequence of rocks consists of an upper and a lower shale separated by a limestone which Spencer (1917, p. 26) divided into three formations: Pilot Shale, Joana Limestone, and Chainman Shale.

Spencer (1917, p. 26) named the Pilot Shale from Pilot Knob in the western portion of the Ely quadrangle. He described it as consisting of soft, highly carbonaceous shales, ranging in color from drab to nearly black. However, since this description was made from pits and tunnels, a description of the Pilot Shale at the surface seems in order. At Eureka, Nevada, the Pilot is a platy, calcareous, dun to black shale which weathers to shades of pinkish or light yellowish brown to gray (Nolan and others, 1956, p. 52).

The writer follows Nolan and others (1956, p. 57) and believes it desirable to reject the usage of Easton and others (1953, p. 149); whereby, the White Pine Shale is retained as a formational name and the Pilot Shale, Joana Limestone, and Chainman Shale are reduced to member status.

Distribution. — The Pilot Shale in the Silver Island Mountains is well exposed in A-1 Canyon in the western portion of the Leppy Range (see pl. 1B and fig. 13). A small section of the Pilot Shale is exposed in Tetzlaff Canyon in the eastern portion of the Leppy Range. The Pilot Shale is not present on Silver Island or Crater Island.

Character and thickness. — A maximum thickness of 425 feet of Pilot Shale was measured and described in A-1 Canyon in the western portion of the Leppy Range (see pl. 3).

The Pilot Shale is a slope-forming, fissile to platy, gray, black and tan siltstone which weathers buff, tan, orange, gray, purple, red, and maroon. Buff and tan are the predominant colors produced by weathering.

In Tetzlaff Canyon, in the eastern portion of the Leppy Range 72 feet of Pilot Shale are present. The siltstone is calcareous at this locality, and over 15 feet of dark blue-gray limestone is present.

Stratigraphic relations. — The conformable contact between the Pilot Shale and the underlying Guilmette Limestone is drawn at the top of a massive, medium-gray limestone, and at the base of a slope-forming, fissile to platy, black siltstone which weathers buff, orange, and tan.

The angularly unconformable contact between the Devonian Pilot Shale and the overlying Mississippian Joana Limestone, in A-1 Canyon, is placed at the top of a sequence of slope-forming, fissile, dark-gray siltstones which weather light gray tan, and at the base of a ledge-forming, thin-bedded, dark blue-black limestone which weathers dark blue-gray and contains chert nodules and stringers.

The angularly unconformable contact between the Devonian Pilot Shale and the overlying Mississippian Chainman Formation, in Tetzlaff Canyon, is tentatively placed at the top of a thin-bedded, argillaceous, dark-gray limestone, and at the base of a dark-gray to maroon quartzite which weathers dark orange tan to orange maroon, and contains occasional quartz and chert pebble conglomerate lenses.

Loughlin (1919, p. 36) summarized evidence for an unconformity between the Devonian and Mississippian in Utah and this unconformity was also noted by Calkins (1919, p. 237-238), Gilluly (1932, p. 22), and Nolan (1935, p. 22). Recently, Brooks (1954) has reported the following information with regard to this unconformity:

> "At the north end of the Confusion Range the Pilot is thinner and is in angular relationship with the overlying Joana (or Madison) limestone. Farther north the Pilot is cut out completely along with a part of the upper Guilmette, the Joana resting on rocks of an undetermined horizon of the Guilmette."

Paleontology. — Sadlick (1959, oral communication) identified the following fauna from a 2-foot limestone bed, 44 feet above the base of the Pilot Shale, in Tetzlaff Canyon.

Unit 2—*Cyrtospirifer* sp.
Tenticospirifer? sp.
Leiorhynchus sp.
fragment of a productid

Age and correlation. — The Pilot Shale is assigned to the Upper Devonian based on a *Crytospirifer* zone (Merriam, 1940, p. 9) and also on the following information. The Pilot Shale of Eureka, Nevada, is divided into two units. The lower unit is more calcareous and some of the beds are thin-bedded, shaly limestones (Nolan and others, 1956, p. 52). A conodont fauna was collected from a sandy limestone in the lower part of the lower unit and assigned to the lower half of the Upper Devonian by W. H.

Hass (1954, in Nolan and others, 1956, p. 53). Based on lithology and stratigraphic position, the lower unit of the Pilot Shale at Eureka, Nevada, may be correlative with the Pilot Shale measured and described in Tetzlaff Canyon, thus adding further substantiation to a Late Devonian age for the Pilot Shale of the Silver Island Mountains.

The Pilot Shale in the Silver Island Mountains is correlated with its type locality at Ely, Nevada, and with the Pilot Shale at Eureka, Nevada, based on lithology and stratigraphic position.

Measured sections. —

Section of the Pilot Shale in
SE1/4 sec. 28, T. 34 N., R. 70 E., Nevada. (unsurveyed)

Mississippian:
Joana Limestone.
Angular Unconformity.
Devonian:
Pilot Shale:

Unit	*Description*	*Feet*
4.	Siltstone, dark-gray; weathers light gray-tan; fissile; forms slope	147
3.	Siltstone, olive brown; weathers buff to medium tan occasionally red and maroon; fissile to platy; forms slope	240
2.	Claystone, light-gray, light-tan, purple; weathers medium tan to yellow orange; conchoidal fracture; laminated, forms ledge	12
1.	Siltstone, black, weathers buff, orange, purple, and tan; fissile to platy; forms slope	26
	Total Pilot Shale	425

Guilmette Limestone.

Section of the Pilot Shale in
SE1/4 sec. 17, T. 1 N., R. 18 W., Utah.

Mississippian:
Chainman Formation.
Angular Unconformity.
Devonian:
Pilot Shale:

Unit	*Description*	*Feet*
4.	Limestone, dark-gray; fine-crystalline; argillaceous; thin-bedded	13
3.	Siltstone, purple to medium-gray, weathers purple to buff; extremely fissile; and occasional 2- to 6-inch beds of argillaceous, fine-crystalline limestone	13
2.	Limestone, dark blue-black, weathers dark blue-gray to dark gray; fine-crystalline; platy to thin-bedded; fossils — *Cyrtospirifer, Leiorhynchus, Tenticospirifer?*	2
1.	Siltstone, medium-tan to medium-gray; weathers buff to orange tan; calcareous; fissile to platy; forms slope	44
	Total Pilot Shale	72

Guilmette Limestone.

MISSISSIPPIAN SYSTEM

In the Silver Island Mountains the Mississippian System is represented by the Joana Limestone and a portion of the Chainman and Diamond Peak Formations undifferentiated.

The Mississippian formations in the Silver Island Mountains range in thickness from approximately 1,400 feet on Silver Island to 300 feet on central Crater Island (modified after Anderson, 1957, p. 64, 69).

The Mississippian section of the Silver Island Mountains is predominantly clastic, and the section is thin compared to the thick Mississippian section in the Oquirrh Basn of central Utah which aggregates a maximum of 5,800 feet in the Stansbury Mountains (Rigby, 1958, p. 38, fig. 5) and over 5,700 feet in the Sheeprock Mountains (Cohenour, 1957, p. 127).

Joana Limestone

History of nomenclature. — The White Pine Shale which was defined by Hague (1892, p. 68-69) consists of a lower and upper shale separated by a limestone. Spencer (1917, p. 26) named a similar limestone the Joana Limestone for exposures near the Joana mine, situated on the south side of Robinson Canyon, 2 miles above Ely, Nevada. Spencer (1917, p. 26) states:

"The Joana Limestone is made up of massive uniformly bluish-gray beds which in a few places contain nodules of chert."

Distribution. — The Joana Limestone is exposed north of Silver Peak and at the head of Silver Island Canyon on Silver Island, Utah, and in A-1 Canyon, in the Leppy Range, Nevada (see pls. 1A and 1B). It is not present elsewhere in the Silver Island Mountains. This is interpreted by the writer to mean erosion after deposition rather than non-deposition.

Character and thickness. — The Joana Limestone is a cliff-forming, thin-bedded, fine-crystalline, black limestone which contains chert nodules and bedded chert with argillaceous material occasionally present alone bedding planes (see pl. 3).

In the Silver Island Mountains the Joana Limestone obtains a maximum thickness of 268 feet on Silver Island.

Stratigraphic relations. — The angularly unconformable contact between the Joana Limestone and the underlying formations is drawn at the base of the first black limestone which contains Mississippian fossils.

In A-1 Canyon, in the Leppy Range, the Joana is angularly unconformable on the Pilot Shale; and on Silver Island the Joana is angularly unconformable on the Guilmette Limestone. The nature of the unconformity

between the Joana Limestone and the underlying Guilmette indicates to the writer that a karst topography developed on the Guilmette Limstone prior to the deposition of the Joana (see fig. 12).

The angularly unconformable contact between the Joana and the overlying Chainman and Diamond Peak Formations undifferentiated is placed at the top of a black limestone with bedded chert and early Mississippian fossils.

Paleontology. — The Joana Limestone on Silver Island yielded the following fossils which were identified by the writer.

Unit 1—*Spirifer centronatus* (abundant)
Productus scabriculus?
Camarotoechia sp.

Unit 4—*Spirifer centronatus*
Orthothetes inflatus?
Reticularia cooperensis?

Walter Sadlick (1959, personal communication) identified the following corals from the above section.

syringoporid coral
pleurotomarid coral
Lithostrotionella sp.

The Joana Limestone in A-1 Canyon yielded the following fossils which were identified by the writer.

Camarotoechia metallica
Camarotoechia herrickana?
Spirifer centronatus
Orthothetes inflatus?

Age and correlation. — Nolan and others (1956, p. 55) assigned an early Mississippian age to the Joana Limestone in the vicinity of Eureka, Nevada based on faunal evidence.

Upon examination of the Joana Limestone and its fossils in the Silver Island Mountains, Walter Sadlick (1959, oral communication) assigned an early Osagean age to the upper beds of the Joana in this area and correlated the formation with the Gardison Limestone of the Madison Group as described by Morris and Lovering in Crittenden (1959, p. 65).

Sadlick states:

"There do not seem to be any beds present in the Silver Island Mountains that contain corals similar to the Fitchville Formation of the Madison Group as described by Morris and Lovering in Crittenden (1959, p. 65)."

The Joana Limestone of the Silver Island Mountains is correlated with its type locality based on lithology, stratigraphic position and faunal evidence.

Measured sections. —

Section of the Joana Limestone in NW1/4 sec. 33, T. 3 N., R. 17 W., Utah. (unsurveyed)

Mississippian:

Chainman Formation.

Angular Unconformity.

Joana Limestone:

Unit	Description	Feet
4.	Limestone, black; weathers black; thin-bedded to platy; argillaceous material on bedding planes; occasional chert nodules and seams; chert, black; weathers dark brown to black; maroon mottling; fossils — *Spirifer centronatus, Orthothetes inflatus ? Reticularia cooperensis?*	222
3.	Limestone, black; fine-crystalline; thick-bedded; occasional chert nodules; occasional maroon mottling	12
2.	Limestone, black; fine-crystalline; massive; chert stringers and nodules; chert, dark-gray to black; weathers orange-brown, numerous calcite veinlets	16
1.	Limestone, black; argillaceous material which weathers light tan to reddish brown; massive; many calcite veinlets; fossils — *Spirifer centronatus, Productus scabriculus, Camarotoechia*	18
	Total Joana Limestone	268

Angular Unconformity.

Devonian:

Guilmette Limestone.

Section of the Joana Limestone in SE1/4 sec. 28, T. 34 N., R. 70 E., Nevada. (unsurveyed)

Mississippian:

Chainman Formation.

Angular Unconformity.

Joana Limestone:

Unit	Description	Feet
1.	Limestone, dark blue-black; weathers dark blue-gray; arenaceous; thin-bedded; irregular bedding planes near base; chert nodules and stringers; chert, dark-blue; weathers dark brown; forms cliff; fossils — *Camarotoechia metallica, Camarotoechia herrickana?, Spirifer centronatus, Orthothetes inflatus?*	20
	Total Joana Limestone	20

Angular Unconformity:

Devonian:

Guilmette Limestone.

Chainman and Diamond Peak Formations Undifferentiated

History of nomenclature. — The Chainman Shale was named for the Chainman mine in the Ely district, Nevada (Spencer, 1917, p. 26-27). The formation "is essentially composed of soft, fissile clay shales grading locally into fine-grained sandy shale". The Chainman is the upper shale of the White Pine Shale as discussed previously in this guidebook.

The Diamond Peak Quartzite was originally described by Hague (1883, p. 266-270) and its type locality is Diamond Peak about 10 miles northeast of Eureka, Nevada. Hague reported that the bulk of the formation is quartzite but that some conglomerate, shale, and limestone in addition to the quartzite are present.

The writer has not differentiated the Chainman and Diamond Peak Formation in the Silver Island Mountains. The difficulty of separating the Chainman and Diamond Peak is best summed up by Nolan and others (1956, p. 56).

> "In particular we have not been able in many places to select a satisfactory boundary between Hague's White Pine shale and his Diamond Peak quartzite; black-shale layers of considerable thickness and comparable in lithologic character to the bulk of the White Pine persist essentially throughout the interval mapped by Hague as Diamond Peak. Quartzite or conglomerate beds, moreover, that in one place might appear to form a satisfactory boundary between the two formations lens out within relatively short distances; a similar bed may then appear several hundred feet higher or lower stratigraphically."

Anderson (1957, p. 65-73) has differentiated the above formations in the northern part of the Silver Island Mountains but the writer believes this differentiation occasionally may be in error. For example, in figure 12, page 66 (Anderson, 1957), the writer believes the Strathearn Formation may have been mismapped as Diamond Peak.

Distribution. — The Chainman and Diamond Peak Formations undifferentiated are exposed throughout the Silver Island Mountains (see pls. 1A, 1B and 2A).

Character and thickness. — The best exposed section of the above undifferentiated sequence was measured on the west side of Tetzlaff Canyon (see pl. 3). The following interbedded lithologies are exposed: dark-gray quartzite which weathers orange-tan; light-gray limestone; fissile, black claystone which weathers purple, black, maroon, tan, and light red; light-gray siltstone which weathers light gray to light orange brown; and medium-tan to gray conglomerate which weathers reddish tan to medium gray. The conglomerate contains angular to subrounded pebbles of chert and quartzite which range in diameter from ½-inch to 2 inches with an average diameter of 1¼ inches. The pebbles are colored orange, green, light-gray, red and black.

The Chainman and Diamond Peak Formations undifferentiated are divided in a general way into five major rock units in the Silver Island Mountains. In ascending order they are as follows: a lower clastic unit; a carbonate unit which locally contains a prolific gastropod fauna; a dominantly shale unit; locally a second carbonate unit; and a conglomerate clastic unit correlative with the Diamond Peak.

A total thickness of 1,141 feet of Chainman and Diamond Peak Formations undifferentiated was measured in Tetzlaff Canyon. An incomplete section of 670 feet was measured in A-1 Canyon. This section is terminated by a fault, and is partially slumped. Another section which portrays the different lithologies of the Chainman and Diamond Peak Formations undifferentiated can be observed north of Silver Peak on Silver Island; however, this section is much faulted. This section is well exposed though and is the best locality to study the Diamond Peak facies of the section.

Stratigraphic relations. — The Chainman and Diamond Peak Formations undifferentiated are angularly unconformable upon post-Joana folded Guilmette Limestone, Pilot Shale, and Joana Limestone. This lower contact is sharp and is drawn at the base of the first quartzite bed.

The upper contact with the Ely Formation is gradational and is placed at the top of the last conglomerate bed of the Diamond Peak Formation.

Paleontology. — Ellis L. Yochelson and J. Thomas Dutro, Jr. (1958, written communication) identified a large gastropod and brachiopod fauna, respectively, from the Chainman and Diamond Peak Formations undifferentiated. The following information is quoted from their letter (significant forms are preceded by an asterisk).

> "Most of the collections from the Chainman Formation represent a faunal assemblage that appears to be widespread in the Great Basin Province. Mackenzie Gordon, of the U. S. Geological Survey, has been studying these fossils in the Confusion Range. Many of the brachiopods are new and include those forms listed below as: *"Dictyoclostus"* cf. *"D." inflatus* (McChesney), *"Dictyoclostus"* sp., *"Buxtonia"* sp., *"Marginifera"* sp., *Spirifer* cf. *S. brazerianus* Girty, *Spirifer* aff. *S. opimus* Hall, *Punctospirifer* cf. *P. transversa* (McChesney), and *Reticularina cf. R. campestris* (White). Included in this group of collections are: F112, F265, F246, F296, F7, F176, F180(?), F295(?), F175(?), F6(?), and F178(?).

According to Mr. Gordon, the association of abundant specimens of *"Dictyoclostus"* cf. *"D." inflatus* (McChesney) and spiriferids of Mississippian-type point to a late late Mississippian age.

This faunule, along with an associated assemblage containing the characteristic *Rhipidomella nevadensis* (White) (see collection F8), is also found in the lower part of the Ely formation, according to Gordon. This may account for three collections, assigned to the Ely by Schaeffer, that contain this faunal assemblage (F182, F184, and F313).

Two collections from the Chainman appear to represent an older part of the Late Mississippian. Collections F231 and F322 both contain *Spirifer* cf. *S. pellaensis* Weller and F231 contains a gigantoproductid that may be *Striatifera brazerianus* (Girty).

Two collections gave some difficulty because of a possible mixing of faunal elements. F112, reported from Chainman unit 12(?), has the common "upper Chainman fauna" but, in addition, there are two specimens of a brachiopod that could well be *Waagenoconcha,* a Permian form. Certain of the gastropods, particularly ?*Straparollus,* also give a post-Mississippian aspect to the collection.

Chainman collections. —

F112 (unit 12 ? — Nevada) —

- *"Productella?"* sp.
- *Linoproductus* sp.
- *"*Dictyoclostus*" cf. *"D." inflatus* (McChesney)
- *"*Dictyoclostus*" sp.
- *"*Buxtonia*" sp.
- *Krotovia?* sp. (may be *Waagenoconcha*)
- *"*Marginifera*" sp.
- *Spirifer* sp.
- *Brachythyris?* sp.
- *Composita* sp.
- *"Martinia"* sp.
- *Hustedia* sp.
- *Euphemites* sp.
- *Bellerophon* sp.
- **Knightites* (*Retispira*) sp.
- **Straparollus* (*Euomphalus*) sp.
- ?*Straparollus* (may be *Discotropis*)
- *Mourlonia* sp.
- ?*Bembexia* sp.
- *?*Worthenia* sp.
- **Glabrocingulum* sp. 1
- *Glabrocingulum* sp. 2
- new genus (cf. *Dictyotomaria*)
- cf. *Rhineoderma*
- indeterminate high-spired gastropod (cf. *Meekospira*)

If this is not a mixed collection, it represents a remarkable association of latest Mississippian age. The mollusks, in particular, are beautifully preserved and quite diversified.

F265 (unit 12 ? — Nevada) —

Derbyia? sp.
*"*Dictyoclostus*" cf. "*D.*" *inflatus* (McChesney)
productoid brachiopod, indet.
**Spirifer* cf. *S. brazerianus* Girty
**Spirifer* aff. *S. opimus* Hall
Composita? sp.
Torynifer? sp.
pectenoid pelecypod, indet.
Bellerophon sp.
**Knightites* (*Retispira*) sp.
*?*Straparollus* (*Euomphalus*) sp.
pleurotomarian gastropod, indet.

This is the characteristic, latest Mississippian, "Chainman fauna."

F245 (unit 8 — Utah) —

Bellerophon n. sp.

F246

rhynchonelloid brachiopod, indet.
Chonetes sp.
*"*Dictyoclostus*" cf. "*D.*" *inflatus* (McChesney)
*"*Dictyoclostus*" sp.
**Spirifer* cf. S. *brazerianus* Girty
Composita sp.
Hustedia? sp.
**Punctospirifer* cf. *P. transversa* (McChesney)
**Reticularina* cf. *R. campestris* (White)

Characteristic "Chainman fauna".

F74

Spirifer sp.
Composita sp.

F231

orthotetid, indet.
*gigantoproductid, indet.
productoid, indet.
**Spirifer* cf. *S. pellaensis* Weller
Composita? sp.

An early Late Mississippian age is suggested (see also F322).

F180 (unit 12 — Nevada) —

crinoid columnals, indet.
"*Productella*"*?* sp.
**Spirifer* sp. (large — may be aff. *S. brazerianus* Girty)

This may represent the typical "Chainman fauna".

F296 (upper) —

Michelinia sp.
Chonetes sp.
*"*Dictyoclostus*" cf. "*D.*" *inflatus* (McChesney)
**Spirifer* cf. *S. brazerianus* Girty
**Spirifer* aff. *S. opimus* Hall
**Reticularina* cf. *R. campestris* (White)
Dielasma? sp.

Typical latest Mississippian "Chainman fauna".

F7 (upper) —

Chonetes sp.
*"*Dictyoclostus*" cf. "*D.*" (*inflatus* (McChesney)
*"*Dictyoclostus*" sp.
**Buxtonia*" sp.
Brachythyris? sp.
Composita? sp.
**Cleiothyradina* cf. *C. sublamellosa* (Hall)

Typical latest Mississippian "Chainman fauna".

F295 (upper) —

Linoproductus? sp.
Brachythyris? sp.
Composita sp.

F176 (Chainman?)

crinoid debris, indet.
Chonetes sp.
*"*Dictyoclostus*" cf. "*D.*" *inflatus* (McChesney)
spiriferoid, indet.

Seems to be the typical "Chainman fauna".

F322 (unit 2 — Nevada) —

"*Productus*" sp.
**Spirifer* cf. *S. pellaensis* Weller
Composita? sp.
pelecypod, indet.
fish tooth, indet.

An early Late Mississippian age is suggested.

F175 (upper?) —

**Spirifer* cf. *S. brazerianus* Girty
Composita? sp.
Hustedia? sp.
pectinoid pelecypod, indet.

Probably the typical "Chainman fauna".

F6 (upper) —

productoid brachiopod, indet.
**Spirifer* aff. *S. opimus* Hall
Eumetria? sp.

Probably the typical "Chainman fauna".

F178 (unit 12 ? — Nevada) —

Chonetes sp."

The following faunal list was placed under the Ely collection by Yochelson and Dutro; however it was collected by Schaeffer from the conglomerate unit of the Chainman and Diamond Peak Formations undifferentiated.

"F8 (uppermost Chainman) —
**Rhipidomella nevadensis* (White)
**Schizophoria resupinoidea* (Cox)
*"*Buxtonia*" sp.
Spirifer sp.
pelecypod, indet.

The *Rhipidomella nevadensis* (White) zone is considered by Gordon to be latest Mississippian or, perhaps, earliest Pennsylvanian."

Collection F112 was obtained from a unit in a fault horse and this unit is correlated with unit 12 in the A-1 section, Nevada, and unit 8 in the Tetzlaff Canyon section, Utah, based on lithology and fauna. No Permian rocks are exposed near the area where F112 was collected and the writer believes that it is doubtful that Permian brachiopods are mixed in the collection; however, some Pennsylvanian brachiopods could possibly be mixed in this collection. The gastropods are believed by the writer to have definitely been collected in place in collection F112.

Sadlick (1958, oral communication) identified the following additional fauna from the Chainman and Diamond Peak Formations undifferentiated of the Silver Island Mountains.

A-1 section, Leppy Range, Nevada.
Unit 2 —*Amvortella* sp.
abundant endothyroids
Unit 12 —*Caninia* sp.
Unit 12?—striate *Goniatites* (F112)

Chainman and Diamond Peak undifferentiated fossils from various sections within the range are as follows:

carbonate unit — striate *Goniatites*
shale unit — *Cravenoceras* sp.
Eumorphoceras sp.
second carbonate unit — three foot zone of *Caninia* sp.
conglomerate unit — *Rhipidomella nevadensis*
Spirifer occiduus (Sadlick)

Age and correlation. — Yochelson and Dutro (1958, written communication) have assigned an early Late Mississippian age to latest Mississippian or earliest Pennsylvanian age for the Chainman and Diamond Peak Formations undifferentiated in the Silver Island Mountains.

In the Silver Island Mountains, Sadlick assigned the following ages to the major rock units of the Chainman and Diamond Peak Formations undifferentiated: carbonate unit — late Valmeyer and early Chester; shale unit — later Chester time; conglomerate unit — early Pennsylvanian.

Steele (1959b) assigned a middle Springeran to middle Morrowan age for the uppermost part of the Diamond Peak in the Eastern Great Basin.

Nolan and others (1956, p. 60-61) assigned a late Mississippian age to the Chainman and stated the following with regard to the fossils of the Diamond Peak:

"The local occurrence of some forms that are usually found in Pennsylvanian rocks in association with upper Mississippian ones suggests that there may be beds that are really early Pennsylvanian in age in the uppermost part of the Diamond Peak Formation. We believe, however, that such beds, if actually present are of small thickness and are confined to the uppermost part of the formation in only a few localities."

The Chainman and Diamond Peak Formations undifferentiated of the Silver Island Mountains are correlated with the Chainman and Diamond Peak Formations undifferentiated in the vicinity of Eureka, Nevada, (Nolan and others, 1956, p. 57) based on lithology and fossils.

Measured sections. —

Section of the Chainman and Diamond Peak Formations undiferentiated in SE1/4 and W1/2 sec. 17, T. 1 N., R. 18 W., Utah

Pennsylvanian:
Ely Formation.
Missisippian-Pennsylvanian:
Chainman and Diamond Peak Formations undifferentiated:

Unit	*Description*	*Feet*
20.	Conglomerate; quartzite pebbles, light-gray; weather medium gray to medium brown; ½-inch in diameter; angular to sub-rounded; matrix, light-gray quartzite; forms ledge	11
19.	Covered	80
18.	Claystone, quartzite and siltstone; interbedded; claystone, orange to olive-brown; weathers black to brown, variegated; fissile to platy; quartzite, light-gray; weathers orange tan; fine-grained; quartzose; siltstone, black; weathers light gray; platy; forms slope	16
17.	Covered	222
16.	Quartzite, dark blue-black; weathers orange-tan; occasional green alteration; forms ledge	9
15.	Claystone, black; weathers medium blue to black; extremely fissile; contact with unit below is gradational; at 24 feet above the base is a 2-foot bed of quartzite, orange-black; weathers orange-tan; medium-grained; forms slope	177
14.	Claystone, black; weathers pale blue to light purple, light tan, and maroon, variegated; extremely fissile, forms slope	29

13.	Siltstone, light-gray, weathers light gray to light orange-brown; variegated; extremely fissile; forms slope	17
12.	Siltstone, light-gray; weathers light gray to light tan, variegated; quartzitic; fissile to platy; altered hematite crystals; forms slope	11
11.	Siltstone, as unit 13	94
10.	Claystone, light-tan; calcareous; fissile to platy; occasional hematite alteration; hematite crystals; forms slope	8
9.	Quartzite, claystone, siltstone and limestone; interbedded; quartzite, medium-orange-tan; weathers light orange tan; fine-grained; claystone, medium orange-brown; weathers light yellow brown; extremely fissile; siltstone, light-gray; fissile to platy; limestone, medium-gray; fine-crystalline; hematite crystals; forms slope	13
8.	Limestone, dark-gray; weathers medium blue gray; fine-crystalline; small amounts of argillaceous material on bedding planes which increases upwards; thin-bedded; forms slope; fossils — *Bellerophon* n. sp.	60
7.	Quartzite, light buff-gray; weathers medium orange brown; fine-grained; calcareous; forms ledge	19
6.	Limestone, light blue-gray; weathers light gray; medium-crystalline; very arenaceous; large amounts of argillaceous material in seams and patches which weather dark brown, argillaceous material more resistant than limestone; forms slope	18
5.	Quartzite and conglomerate; quartzite, medium blue-gray; weathers medium to dark tan; medium-grained; calcareous; conglomerate; matrix, medium-tan; weathers reddish tan; chert and quartz pebbles, orange, green and red, average ⅛-to ¼-inch in diameter; conglomerate is near base of unit; medium-bedded; cross-bedded; forms ledges	53
4.	Siltstone, light gray-purple; weathers light purple; fissile to platy, small hematite crystals; forms slope	27
3.	Quartzite and conglomerate, interbedded; quartzite, light-gray; weathers dark tan; medium-grained; conglomerate, as unit 5; thin -to medium-bedded; prominently cross-bedded in middle of unit; forms ledges	107
2.	Claystone, black; weathers purple to light red (purple predominates) and buff to gray; extremely fissile; 69 feet above the base of unit is a 4-inch bed of lithographic limestone, black; weathers orange-maroon; forms slope	119
1.	Quartzite; dark-gray to maroon; weathers dark orange-tan to orange-maroon; fine-grained; slightly calcareous, some mafic minerals present; occasional beds of conglomerate; quartz and chert pebbles orange, red, and green; average ¼-inch in diameter; angular to sub-rounded; platy to thin-bedded; forms slope	51
	Total Chainman and Diamond Peak Formations undifferentiated	1,141

Angular Unconformity.

Devonian:

Pilot Shale.

Section of the Chainman and Diamond Peak Formations undifferentiated in S½ sec. 28, T. 34 N., R. 70 E., Nevada

Pennsylvanian:

Ely Formation.

Fault

Mississippian-Pennsylvanian:

Chainman and Diamond Peak Formations undifferentiated (incomplete):

Unit	*Description*	*Feet*
12.	Limestone, dark-gray; weathers medium gray; fine-crystalline; thin-bedded; occasional purple mottling; iron coated bands, dark orange-brown; argillaceous material; bedded chert, black, 4 to 6 inches in thickness, in middle of unit; forms slope; fossils — *"Productella"*? sp., *Spirifer* sp., gastropods, crinoids	40
11.	Conglomerate; matrix, orange; weathers medium orange; chert and quartzite pebbles, light-gray to black; ½-inch to 2 inches in diameter, average 1¼-inches, pebbles average ¼-inch in upper portion of unit; forms ledge	18
10.	Limestone, black; weathers medium orange-tan; fine-crystalline; very arenaceous; massive; irregular bedding planes; forms cliff	32
9.	Claystone, brownish-black; weathers dark blue gray to light purple; fissile; occasional beds of limestone, black; weathers light tan-gray; fine-crystalline; silty; forms slope	65
8.	Limestone, black weathers medium orange gray; argillaceous; forms ledges	8
7.	Quartzite, olive-green, weathers medium olive green, fine-grained; forms ledges	9
6.	Siltstone, medium-gray; weathers light gray to dark orange, variegated; platy to thin-bedded; forms slope	30
5.	Claystone, brownish-black; weathers dark blue gray to light purple; fissile; occasional beds of limestone and conglomerate; limestone, black; weathers light tan gray; fine-crystalline; silty; conglomerate, light orange-tan, weathers medium orange, calcareous; forms slope	142
4.	Covered	152
3.	Quartzite, dark blue-gray; weathers medium to dark orange brown; fine-grained; thin-bedded; forms slope	31
2.	Siltstone, black; weathers orange tan; platy; and a 2-foot limestone bed, black; weathers dark blue-gray, F_{322}; forms slope; fossils — *"Productus"* sp., *Spirifer* cf. *S. pellaensis, Composita?* sp., pelecypod indet., fish tooth, indet	50
1.	Siltstone and quartzite; siltstone, black to olive-brown; weathers buff; platy; lateral facies change to quartzite in basal 30 feet of unit; quartzite, as unit 3 except fine- to medium-grained; forms slope	93
	Total Chainman and Diamond Peak Formations undifferentiated (incomplete)	670

Angular Unconformity.

Mississippian:

Joana Limestone.

PENNSYLVANIAN SYSTEM

In the Silver Island Mountains, the Pennsylvanian System is represented by the upper portion of the Chainman and Diamond Peak Formations undifferentiated, Ely Formation, and lower portion of the Strathearn Formation. The Pennsylvanian formations range in thickness from approximately 1900 feet in the Leppy Range to approximately 200 feet on Crater Island.

Ely Formation and Oquirrh (Lower Portion) Formation Undifferentiated

History of nomenclature. — The Ely Limestone was proposed by Lawson (1906, p. 295) for a cherty limestone sequence exposed in the Robinson Mining district, Nevada, and was used by him in describing the lowest formation of Pennsylvanian age in the Ely district, Nevada.

In the Elko and north Diamond Ranges of northeast Nevada, Dott (1955, p. 2234) named the Moleen and Tomera Formations which together are essentially equivalent in time to the Ely Limestone of east-central Nevada. Dott (1955, p. 2234) proposed that the Ely be elevated to group rank to include the Moleen and Tomera Formations. Steele (1959b) is in disagreement with Dott's usage of the Ely for the following reasons:

> "The lithology of the type Ely Limestone as defined by Pennebaker is a limestone sequence with abundant bedded to nodular, black to tan colored chert. Clastic chert is less than 5 per cent in the type Ely, while the Moleen and Tomera Formations contain 15 per cent to 20 per cent Vinini-Kinikinnic derived chert and quartzite clastics. Lithologically the Moleen and Tomera Formations reflect the more tectonically active environment under which they were deposited, while the Ely limestone reflects only the gentle positive tendency of the West Central Utah Uplift."

Steele (1959b) suggested that the Ely Limestone be dropped from group rank to formational status, and that it be restricted in usage to those limestones lying stratigraphically above the White Pine Shale and below the middle Pennsylvanian unconformity. Dott (1955, p. 2219, fig. 2) has limited the Ely to the same stratigraphic boundaries.

Th general stratigraphic term, "lower portion of the Oquirrh Formation," is used by the writer to denote the more clastic facies of the Ely Formation.

James Gilluly (1932, p. 32-34) named the Oquirrh Formation from exposures in the Oquirrh Mountains twenty miles northwest of Provo, Utah. The Oquirrh Formation in its type area consists of approximately 15,000 feet of interbedded limestones, quartzites and sandstones.

The geographical position of the Silver Island Mountains places it in the transition zone between the lithologies of the Ely and the lower portion of the Oquirrh (Steele, 1959b); therefore, the Ely and lower portion of the Oquirrh Formations are undifferentiated in this area. This transition between the Ely and lower portion of the Oquirrh is based upon quartz clastic content; the Oquirrh having the greater percentage (Steele, 1959b).

Distribution. — The Ely and Oquirrh (lower portion) Formations undifferentiated are exposed in the Leppy Range, Silver Island and Floating Island (see pls. 1A, 1B, and fig. 14). Two exceptionally good sections may be seen at A-1 Canyon, Leppy Range, Nevada, and at Rishel Peak, Leppy Range, Utah.

Character and thickness. — The Ely and Oquirrh (lower portion) Formations undifferentiated can be divided into two members in the Silver Island Mountains (see pl. 3 and fig. 14).

The lower member consists mainly of fine- to medium-crystalline, medium- to dark-gray limestone which weathers light to medium gray and contains bedded and nodular chert throughout. The lower member aggregates 1275 feet in the Leppy Range.

The upper member is composed of 75 per cent calcareous siltstone and 25 per cent argillaceous limestone. It aggregates 466 feet in the Leppy Range. The calcareous siltstone is red-brown to red-gray and weathers a buff pink. It is thin-bedded and contains abundant 1-inch spherical concretions of siltstone. Chert nodules are scattered throughout the member. The argillaceous limestone is light- to dark-gray, fine- to coarse-crystalline, and medium-bedded. The limestone is interbedded with the siltstone.

The Ely and Oquirrh (lower portion) Formations undifferentiated are easily traced throughout the area mapped.

Stratigraphic relations. — The lower conformable contact of the Ely and Oquirrh (lower portion) Formations undifferentiated is placed at the top of the last conglomerate bed of the Diamond Peak Formation.

The upper angularly unconformable contact between Ely-Oquirrh (lower portion) Formations undifferentiated and the Strathearn Formation is placed at the base of a chert-pebble, brown-gray conglomerate which has a silty, pink to brown limestone matrix.

The facies change between the Ely and lower portion of the Oquirrh Formation can be observed at Rishel Peak, Leppy Range, Utah (Steele, 1959b).

The above facies change is subtle but there is a definite increase in the siltstone content of the lower member of the Ely. In fact, the siltstone content of the lower member of the Ely in the Nevada portion of the Leppy Range is almost non-existent. Thus the general stratigraphic term "lower portion of the Oquirrh Formation" is applied to the sequence of rocks eastward from Rishel Peak which are equivalent in time to the Ely.

Paleontology. — Steele (1959b) has collected and identified the following microfossils from the Ely Formation in the Leppy Range at Wendover:

"Collected near the upper contact —
Wedekindellina sp.
Fusulina insolita
Fusulina taoensis

Collected near the lower contact —
Millerella marblensis
Millerella cf. *M. inflecta*"

E. L. Yochelson and J. F. Dutro, Jr. (1958, written communication) have identified the macrofossils collected by the writer from the Ely Formation. Their identifications and notes on age assignments where significant are reported as follows (significant forms preceded by an asterisk):

"*Ely Collections*—

F108 (Ely)—
Reticularina aff. *R. campestus* (White)
Hustedia sp.
brachiopod, indet.
*?*Peruvispira* sp.

Collection F108, reported from the Ely formation contains the gastropod ?*Peruvispira* which, according to its presently known range, is confined to the Permian.

F204 (top of lower member)—
Rhipidomella? sp.
**Spirifer* cf. *S. occidentalis* Girty
**Neospirifer* sp.

F316 (upper member)—
chonetid brachiopod, indet. (possibly *Lissochonetes*
dictyoclostid brachiopod, indet.

F206 (upper member)—
Dictyoclostus sp.
Wellerella sp.
Cleiothyridina sp.
Hustedia sp.

F314 (Penn. or Perm.?)—
dictyoclostid brachiopod, indet. (possibly *Antiquatonia*)

F205 (basal upper member)—
Rhipidomella sp.
"Marginifera" sp.
Cleiothyridina sp.

F313 (Ely?)—
Chonetes? sp.
*"*Dictyoclostus*" cf. "*D.*" *inflatus* (McChesney)
*"*Buxtonia?* sp.
**Linoproductus* cf. *L. pileiformis* (McChesney)

This represents the typical "Chainman fauna" as used in this report. It is known from the lower Ely, as well.

F75 (lower member)—
**Neospirifer* sp.
fish tooth, indet.

F184 (Ely?)—
orthid brachiopod, indet.
Chonetes sp.
*"*Dictyoclostus*" cf. "*D.*" *inflatus* (McChesney)
**Spirifer* aff. *S. brazerianus* Girty
**Reticularina* cf. *R. campestris* (White)

This is probably the typical "Chainman fauna" of latest Mississippian age.

F182 (Ely)—
orthotetid, indet.
**Linoproductus* cf. *L. pileiformis* (McChesney)
*"*Dictyoclostus*" cf. "*D.*" *inflatus* (McChesney)
*"*Buxtonia*" sp.
Wellerella? sp.
**Spirifer* cf. *S. brazerianus* Girty
**Spirifer* aff. *S. opimus* Hall
Composita cf. *C. subquadrata* (Hall)
**Cleiothyridina* cf. *C. sublamellosa* (Hall)
Hustedia sp.
Eumetria? sp.
**Punctospirifer* cf. *P. transversa* (McChesney)
**Reticularina* cf. *R. campestris* (White)

This collection contains most of the elements of the typical "Chainman fauna", closely resembling F246, for example.

F201 (lower member)—
*"*Dictyoclostus*" cf. "*D.*" *coloradoensis* (Girty)

F315 (top of lower member)—
*orthotetid, indet. (possibly *Derbyia*)
*"*Marginifera*" sp.
**Neospirifer* sp. (large)
**Hustedia* sp.

F1 (upper member, probably)—
Orbiculoidea sp.

F76 (lower member)—
crinoid debris, indet.
bryozoan, indet.
productoid brachiopod, indet.
**Spirifer* aff. *S. occidentalis* (Girty)
pelecypod indet.

F59 (lower member, probably)—
*"Dictyoclostus" cf. "D." coloradoensis (Girty)
Phricodothyris? sp.
F57 (Penn. or Permian?)—
dictyoclostid brachiopod, indet."

Age and correlation. — Steele (1959b) has dated the lower contact of the Ely and Oquirrh (lower portion) Formations undifferentiated in the Leppy Range as late Morrowan and the upper contact as early Desmoinesian (based on microfossils).

Yochelson and Dutro (1958, written communication) report the following with regard to the age of the Ely Formation in the Silver Island Mountains (based on macrofossils):

"Several of the collections from the Ely Formation contain elements of a fossil assemblage that is considered Middle Pennsylvania (Middle Pennsylvanian as used by the U.S.G.S. includes Atoka and Des Moines equivalents). Among these species are: *Derbyia* sp. *"Marginifera"* sp., *"Dictyoclostus"* cf. *"D." coloradoensis* (Girty), *Neospirifer* sp., *Spirifer* cf. *S. occidentalis* (Girty), and *Hustedia* sp. Included in these collections are: F204, F75, F201, F315, F76, F59, F316(?), F206(?) and F205(?)."

The Ely Formation of the Silver Island Mountains is correlated with the Ely Limestone in the vicinity of Eureka, Nevada, on lithologic and faunal evidence.

The Oquirrh Formation in the south-central Wasatch Mountains was dated, based on fusulinids, by A. A. Baker (1947) as Morrowan to Wolfcampian in age. The lower portion of the Oquirrh Formation in the Silver Island Mountains is correlated with the equivalent time interval of the type Oquirrh Formation in the Oquirrh Mountains, Utah, on lithologic and faunal evidence.

The lower member of the Ely and the Oquirrh (lower portion) Formations undifferentiated in the Silver Island Mountains is the time equivalent of the Moleen Formation of Dott (1955); of the West Canyon member of the Oquirrh Formation of Nygreen (1958); and of the Hall Canyon and Meadow Canyon (in part, if not entirely) of Bissel (1959). The upper member of the Ely and Oquirrh (lower portion) Formations undifferentiated is the time equivalent of the Tomera Formation of Dott (1955).

Measured section. — This section was measured by a confidential source. The writer informed the confidential source as to the geographic location and stratigraphic position of the section in exchange for the description of the measured section.

Section of the Ely and Oquirrh (lower portion) Formations undifferentiated in SW¼ sec. 18, and NW¼ sec. 19, T. 1 N., R. 18 W., Utah

Pennsylvanian:

Strathearn Formation.

Angular Unconformity.

Ely and Oquirrh (lower portion) Formations undifferentiated:
Upper member:

Unit	*Description*	*Feet*
35.	Limestone, pink- to brown-gray; fine-crystalline with local coarse zones; slightly silty; dense; gray chert nodules and lenses; thin-bedded; forms cliff; fossils — local crinoid debris	55
34.	Limestone (70%) and siltstone (30%), interbedded; limestone, dark-gray; fine-crystalline, slightly silty; dense; hard; thin-bedded; sitlstone, red- to brown-gray; very calcareous, very argillaceous quartz silt; Fe stain; thin-bedded	45
33.	Siltstone, as unit 34 except with scattered small chert nodules; weathers to slope with 3-foot bioclastic, dark-gray limestone at center; fossils — abundant small branching corals	87
32.	Limestone, light- to medium-gray; weathers tan and gray bands; fine-crystalline, very silty, occasional clastic? appearance; dense; hard; minor bioclastic zones; massive; forms cliff; fossils — horn corals	43
31.	Siltstone, red-brown to red-gray; weathers to buff pink slope; slightly argillaceous, calcareous cement; well indurated; quartz grains; Fe stain; very thin-bedded; 1-inch spherical concretions in basal part	236
	Total Upper member	466

Lower member

Unit	*Description*	*Feet*
30.	Limestone, medium-gray; coarse-crystalline; recrystallized?, clastic?; dense; abundant fossil fragments — crinoid, horn coral, lower — middle Atoka fusulinids	55
29.	Limestone, light -to medium-gray; very-fine to fine-crystalline, minor coarse-crystalline zones, slightly silty (quartz); minor chert lenses; forms color banded cliff; fossils — lower-middle Atoka fusulinids	75
28.	Limestone, dark gray-black; micro-crystalline; dense black chert nodules (3 inches to 2 feet in length) in lower part and beds (2 to 4 inches in thickness) in upper part	60
27.	Limestone, medium-gray; fine- to medium-crystalline; maybe locally clastic; thin- to medium-bedded; fossils — common horn corals, fusulinids	28
26.	Limestone, dark-gray; very fine-crystalline; dense; scattered quartz silt; chert in upper 6 feet; occasional fossil fragments — crinoid, fusulinid	41
25.	Limestone, dark-gray; medium-to coarse-crystalline; very silty, pink matrix; clastic-bioclastic; dense, hard; minor chert beds 6 inches in thickness to 6 feet; fossil — possible lower Atoka fusulinids	20
24.	Limestone (50%) and chert (50%), interbedded (partly covered); limestone, dark-gray; fine- to medium-crystalline, silty; dense; laminated; chert, gray; beds 1 to 3 inches in thickness unit forms cliff; fossil — possible lower Atoka fusulinids	50
23.	Limestone (partly covered), dark-gray; fine- to medium-crystalline, silty; laminated; dense	48
22.	Siltstone (partly covered), dark brown-gray; weathers pink; very calcareous and argillaceous cement; quartz; silt; thin-bedded; forms slope	25
21.	Limestone, dark-gray; fine-crystalline; dense; gray chert nodules to ¼-inch with interbeds of limestone, light dark-gray; coarse-crystalline; clastic-bioclastic; fossil fragments	41

20.	Limestone, dark-gray; fine-crystalline; dense; gray chert band; fossil fragments	85
19.	Limestone, light -to dark-gray; weathers to color banded ledges; fine- to medium-crystalline; dense; gray chert in thin bands; scattered quartz silt; fossil fragments — crinoid brachiopods, occasional fusulinids — lower Atoka	155
18.	Limestone, light- to brown-gray; bioclastic?; red, slightly silty, calcareous matrix	15
17.	Limestone, light- to dark-gray, local pink zones; fine-crystalline, locally slightly silty; hard; chert bands, lenses and nodules; forms color banded ledges; minor fossil debris	115
16.	Limestone, white to light gray; sucrose; thin siliceous beds weathering out as ⅛- to 1-inch dark brown bands	26
15.	Limestone, medium-gray; fine-crystalline; slightly sandy fine quartz; thin-bedded; gray chert band 8 to 10 inches decreasing upward to ½- to 1-inch nodules; forms cliff; fossil debris — brachiopods, crinoids, bryozoan	45
14.	Limestone, dark-gray; very fine-crystalline, silty; siliceous at base; cherty; forms cliff; fossil debris — crinoid, bryozoan	6
13.	Covered	18
12.	Limestone, as unit 14	3
11.	Limestone, medium-gray; very fine-crystalline; dense; hard; pure; with interbeds of limestone, dark gray; fine-crystalline; silty; 1- to 2-inch bands and nodules of gray chert	24
10.	Covered, possible minor fault	55
9.	Limestone, medium- to dark-gray; fine-crystalline; slightly silty; clastic?; argillaceous; dense; very thin-bedded	16
8.	Limestone, gray-pink very fine-grained; clastic; quartz silt, dense; abundant silicified fossils — *Spirifer, Composita*	16
7.	Limestone, dark-gray; medium- to coarse-crystalline, slightly silty; silt composed of euhedral corroded quartz crystals; clastic?	16
6.	Limestone, medium-gray; very fine-crystalline; dense; minor fossil debris	5
5.	Limestone, medium-gray; dense; fine-crystalline, silty; argillaceous; laminated; with ½- to 2-inch dark-gray, clastic limestone beds; 1- to 2-inch, brown chert nodules; fossils — 1-foot algal zone at base	10
4.	Limestone, dark-gray; coarse-crystalline; clastic?; thick-bedded to massive; fossil debris — crinoid, brachiopod	34
3.	Limestone, light- to dark-gray; fine-microcrystalline; sucrose with thin zones coarse-crystalline, clastic?; siliceous; gray chert in irregular lenses in lower part decreasing to scattered nodules in upper part; 2 feet of angular pebble conglomerate in lower ⅓; massive; forms ledges; fossil fragments — crinoid, *Spirifer,* horn coral, 1- to 2-foot zones of concentrated *Spirifer* hash in upper 10 feet, possible upper Morrowan fusulinid near base	78
2.	Limestone, medium-gray; clastic?, some zones of fine-crystalline, locally bioclastic; a few scattered medium-fine quartz grains in middle part; gray chert in 2- to 4-inch irregular lenses give outcrop a banded appearance; fossil hash — bryozoan, crinoid, a few horn corals	76
1.	Covered	34
	Total Lower member	1,275
	Total Ely and Oquirrh (lower portion) Formations undifferentiated	1,741

Diamond Peak Formation.

PERMIAN SYSTEM

The Permian System, in the Silver Island Mountains, is represented by the following undifferentiated formations: Strathearn (upper portion), Riepetown, Ferguson Springs, Oquirrh (upper portion), and Pequop. The exposed portions of these formations have a maximum thickness of approximately 2,500 feet and the section is incomplete due to faulting and Tertiary cover. Probably younger Permian and even Lower Triassic strata are present in the area under the basin fill.

Steele (1959b) has described exposures of the Phosphoria and Gerster Formations in the Silver Island Mountains. The locality is in the southwestern extension of the Leppy Range, sec. 19, T. 34 N., R. 70 E., Elko County, Nevada. The writer was unable to locate these outcrops.

PENNSYLVANIAN-PERMIAN

Strathearn Formation, Riepetown Sandstone, Ferguson Springs Formation, Oquirrh (upper portion) Formation, and Pequop Formation Undifferentiated

History of nomenclature. — The Strathearn Formation was named by Dott (1955, p. 2248) for exposures on the South Fork of the Humboldt River in the Elko Range, Nevada. It consists of "quartz-silty limestone and thin, commonly cross-bedded, chert granule and pebble conglomerate" (Dott, 1955, p. 2248).

The general stratigraphic term, "upper portion of the Oquirrh Formation", refers to the Oquirrh-like rocks in the eastern portion of the Silver Island Mountains which are the time equivalents of the Strathearn, Riepetown and Ferguson Springs in the western portion of the Silver Island Mountains (Steele, 1960, written communication).

The Riepetown Sandstone was named by Steele (1960) after the town of Riepetown in the Ruth Mining District west of Ely, Nevada.

The Ferguson Springs Formation was named by Steele (1960). Steele (1959b) states:

> "The Ferguson Springs Formation in this study refers to those limestones occurring above the middle Pennsylvanian regional unconformity and stratigraphically below the Pequop Formaiton (Steele, 1959a) of Leonardian age. The type section of Ferguson Springs is located in sec. 16, T. 30 N., R. 69 E., Elko County, Nevada. . . . The age is upper-lower Missourian to upper-upper Wolfcampian and it is 3,085 feet in thickness at the type section.

The Ferguson Springs is a light to medium-gray crypto- to medium-crystalline, bioclastic, silty, limestone sequence with thin interbeds of bituminous shale. Locally white, gray, and black chert nodules and thin chert beds are present. Fusulinid coquinas and massive coralline limestones occur in the upper beds of Virgilian age and in the Wolfcampian section."

The Pequop Formation was named by Steele (1960). Steele (1959b) states:

> "The Pequop Formation was named by Steele (1959a, p. 1105) for a thick sequence of thin-bedded fusulinid-bearing limestones measured in the Pequop Range, sec. 3, T. 33 N., R. 65 E., Elko County, Nevada.
>
> The Pequop Formation is composed of purplish-gray, irregularly bedded, platy, silty limestone with interbedded fusuline coquinas."

Steele (1960, written communication) further states:

> "The lower contact of the Pequop formation is placed at the base of a red silt member which overlies the Wolfcampian age massive limestones of the Ferguson Springs formation. The upper boundary is placed at the base of the Loray formation of Lower Guadalupian age."

The writer has not differentiated the preceding Pennsylvanian-Permian formations in the Silver Island Mountains because of the reasons discussed below.

In the Silver Island Mountains the Strathearn, Oquirrh (upper portion), and Riepetown are relatively thin, variable in thickness due to facies changes, and are cliff-forming. Thus, these formations were not mapped separately. The Ferguson Springs and Pequop Formations have a large thickness in the range, but the writer was unable to differentiate these formations except by the use of fusulinids; thus, these formations were not mapped separately. Steele (1960, written communication) states:

> "The contact between the Ferguson Springs formation and the Pequop formation in your area is not a sharp contact as it is in the other areas, but one can call the boundary within a transition zone of twenty to thirty feet. These formations are not time-rock units but are valid lithic units."

On Crater Island, in the northern part of the Silver Island Mountains, Anderson (1957, pp. 77 and 78) has reported a clastic-carbonate and a carbonate lithofacies which were deposited during Late Pennsylvanian and Early Permian time. In regard to the clastic-carbonate facies Anderson states:

> "An unnamed formation consisting of clastic-carbonate facies deposits of Upper Pennsylvanian-Lower Permian age is present in the northwest Crater Island area. The formation pinches out in central Crater Island and thickens northwesterly, indicating a northerly source. Lithologically, it consists of impure, very fine-grained, brownish-gray orthoquartzite, grading upward into medium gray dolomite. The entire formation weathers brown and forms blocky ledges and slopes.

> The lateral and upper contacts with carbonate facies of Permian age are gradational."

Anderson estimates the clastic-carbonate facies to be 600 feet in thickness.

The lower two-thirds of the carbonate facies consists of the dark-gray and bluish-gray fusulinid and crinoidal limestone that is thin-bedded to massive. Occasional dark chert beds and lenses are present in the lower part. This portion of the carbnate facies aggregates 1,386 feet (Anderson, 1957).

The upper one-third of the carbonate facies consists of 422 feet of porcelaneous, silty, gray dolomite which weathers brown and bluish-gray, and contains chert nodules (Anderson ,1957, p. 84 and 85).

Distribution. — The Strathearn, Riepetown, Ferguson Springs, Oquirrh (upper portion), and Pequop are exposed throughout the Silver Island Mountains (see pls. 1A and 1B).

Character and thickness. — Brown-gray chert-pebble conglomerate beds with a pink silty limestone matrix, which weathers brown, are present in the lower 287 feet of the undifferentiated Pennsylvanian-Permian sequence. The conglomerate beds are interbedded with limestones, siltstones and dolomites and show considerable thickness range. The remainder of the undifferentiated sequence consists of a monotonous sequence of fossiliferous, medium- to dark-gray limestones; interbedded with occasionally fossiliferous gray, brown, tan siltstones; sandstones which weather various hues of red, orange, maroon; and a few dense, light-gray dolomite beds. This monotonous sequence aggregates 2,552 feet and is terminated by a fault of large displacement (see pl. 3).

Stratigraphic relations. — The Strathearn Formation rests with an angular unconformity on the Ely Formation in the Leppy Range and on the Chainman-Diamond Peak Formations undifferentiated in Crater Island. The lower contact of the Strathearn Formation is placed at the base of the chert-pebble conglomerates.

The upper contact of the undifferentiated Strathearn, Riepetown, Ferguson Springs, Oquirrh (upper portion), and Pequop is faulted against the Ely Formation. The writer was unable to locate any exposures of younger Permian strata within the range.

Steele (1959b and emended 1960, written communication) reports the following information with regard to the undifferentiated Pennsylvanian-Permian sequence in the Silver Island Mountains:

> "In the Wendover area three good exposures of the Strathearn Formation can be seen. The western most exposure (sec. 4, T. 33 N., R. 70 E., Elko County, Nevada) occurs in a large fault block on the

west side of the Leppy Range. At this locality the Strathearn Formation rests with no visible angularity on lower Demoinesian beds of the Ely limestone. Fusulinids of middle Virgilian age are present 12 feet above the base of the formation in a sequence of thin, bioclastic limestones interbedded in chert grits and chert pebble conglomerates. At Pyramid (Rishel) Peak, the Strathearn Formation is 125 feet in thickness and rests disconformably on the tan silts and limestones of the transition facies between Ely and Oquirrh. At Crater Island, the Strathearn Formation is present but was not measured by the writer. At Lost Canyon, 12 miles northeast of Pyramid (Rishel) Peak, the Strathearn Formation is 264 feet in thickness and rests on the lower member of the Oquirrh Formation.

In the Leppy Range, a thin, tan, calcareous siltstone unit with middle to lower-upper Wolfcampian fusulinids is gradational with the underlying Strathearn Formation. . . .

At Pyramid (Rishel) Peak, and the Leppy Range in general, the lower beds of the Riepetown Sandstone rest on the upper beds of the Strathearn Formation and below the silty limestone of the Ferguson Springs Formation. The Riepetown Sandstone is 20 feet in thickness at Pyramid (Rishel) Peak and could be easily mistaken for the upper beds of the Strathearn Formation. . . ."

The Ferguson Springs Formation grades into the Oquirrh (upper portion) Formation on Crater Island in the northern Silver Island Mountains.

Steele (1959b) states:

"Lithologically similar lower Leonardian age fusulinid limestones rest conformably on upper Wolfcampian Ferguson Springs limestone at Pyramid (Rishel) Peak in the Leppy Range. On the back slope of Pyramid (Rishel) Peak 700 feet of medium to dark purplish-gray silty limestones are assigned to the Pequop Formation.

At Pyramid (Rishel) Peak in the Leppy Range, continuous with 700 feet of lower Leonardian age limestone of the Pequop Formation, is a very thick sequence of irregularly bedded, purplish-gray to dark-gray, silty, fusulinid-bearing limestones dated middle Leonardian. This sequence, approximately 1900 feet, represents the thickest known occurrence of the Pequop Formation in the Butte-Deep Creek Trough.

Upper Leonardian Pequop Formation strata, measuring from 700 feet to 1,450 feet in thickness, are present . . . on the back slopes of Pyramid (Rishel) Peak.

Lower Guadalupian age limestones of the Pequop Formation are present at . . . Pyramid (Rishel) Peak."

Paleontology. — Grant Steele and associates of the Gulf Oil Corporation (1957, 1958, written communicaion) identified the fusulinids collected by the writer from the Ferguson Springs and Pequop Formations in the Silver Island Mountains and assigned ages to the containing rocks. Identifications

and age assignments are given in the following paragraphs. The collections were obtained in four major traverses and in one isolated locality. The four major traverses were collected as follows: (1) samples 11 through 16 on Rishel Peak, Leppy Range, Utah; (2) samples 81 through 104 on a large downfaulted block along the west side of Silver Island, Utah; (3) samples 116 through 137 westward side A-1 Canyon, Leppy Range, Nevada; (4) samples 144 through 170 on the spur extending south of Volcano Peak, Leppy Range, Utah.

F11	*Schwagerina wellsensis* *Schwagerina elkoensis*	middle Wolfcamp
F14	*Schwagerina* aff. *youngquisti* *Schwagerina* cf. *wellsensis*	upper Wolfcamp to lower Leonard
F16	*Schubertella melonica* *Schwagerina gulf* n. sp. *Parafusulina?* sp. *Schwagerina* cf. *gracilitatis* *Schwagerina* aff. *hessensis*	lower Leonard
F26	*Schubertella* cf. *melonica* *Schwagerina* sp. *Schwagerina* aff. *hawkinsi*	lower middle Leonard
F81	*Schwagerina gulf* n. sp.	lower Leonard
F83	*Schwagerina* sp.	lower Leonard
F84	*Schubertella* sp. *Schwagerina* n. sp. *Schwagerina* cf. *franklinensis* *Schwagerina* sp.	lower Leonard
F85	*Schubertella* sp. *Schwagerina* n. sp. *Schwagerina* sp.	lower Leonard
F86	*Schwagerina* sp.	Leonard (poor)
F103	*Schwagerina?* sp.	Leonard (poor)
F104	*Schwagerina* sp. *Parafusulina* sp. *Parafusulina* aff. *bakeri*	middle to upper Leonard
F116	*Schwagerina* sp.	middle Leonard
F121	*Schwagerina* sp.	middle Leonard
F123	*Schwagerina* aff. diversiformis	upper lower Leonard
F125	*Parafusulina? calx*	lower Leonard
F126	*Schwagerina* aff. diversiformis	lower Leonard
F128	*Schwagerina gulf* n. sp.	lower Leonard
F129	*Schwagerina gulf* n. sp.	lower Leonard
F130	*Schwagerina* sp. *Parafusulina?* sp.	lower Leonard
F131	*Parafusulina?* aff. *calx*	upper Wolfcamp
F133	*Schwagerina* aff. *compacta*	upper Wolfcamp
F134	*Schwagerina* aff. *compacta* *Paraschwagerina* sp.	upper Wolfcamp
F135	*Schwagerina* cf. *aculeata* *Schwagerina* aff. *andresensis*	upper middle Wolfcamp
F136	*Schwagerina* cf. *wellsensis* *Schwagerina* aff. *compacta*	middle Wolfcamp
F137	*Schwagerina* aff. *aculeata?* *Schwagerina gulf* n. sp.	middle Wolfcamp

F144	*Schwagerina* sp.	middle Wolfcamp
F145	*Schwagerina* sp.	middle Wolfcamp
F146	*Schwagerina* sp.	Wolfcamp (poor)
F147	*Schwagerina* aff. Youngquisti	middle Wolfcamp
F148	*Pseudoschwagerina* sp.	middle Wolfcamp
F149	*Schwagerina* cf. *neolata*	nc assignment
F150	*Pseudoschwagerina* cf. *rhodesi* *Pseudoschwagerina* aff. *texana* *Schwagerina* cf. *wellsensis*	upper middle to lower upper Wolfcamp
F151	*Parafusulina gulf* n. sp.	Leonard
F153	*Schwagerina* aff. *diversiformis*	lower Leonard
F155	*Parafusulina* cf. *bakeri* *Parafusulina? calx* *Schwagerina* cf. *laxissima* *Schwagerina* aff. *gracilitatis*	lower Leonard (possibly middle Leonard)
F157	*Parafusulina* sp.	middle Leonard
F163	*Parafusulina?* aff. *turgida*	upper Leonard or lower Guadalupian
F168	*Schwagerina* sp. *Parafusulina* aff. *diabloensis*	lower Guadalupian
F169	*Parafusulina* aff. *diabloensis* *Schwagerina* n. sp. *Schwagerina* sp.	lower Guadalupian
F170	*Parafusulina* sp. *Schwagerina*	lower Guadalupian

Yochelson and Dutro (1958, written communication) identified the following macrofossils collected by the writer from the Ferguson Springs and Pequop Formations in the Silver Island Mountains. Their identifications and notes on age assignments are given below (significant forms are preceded by an asterisk). Fossils listed under Pequop Formation also include fossils from the Ferguson Springs Formation.

"Permian

F124—(Pequop)—
Composita sp.
Phricodothyris? sp.

F120—(Pequop?)—
spiriferoid brachiopod, indet.

Permian (Pequop Formation) —

F208—(middle Wolfcamp)—
Straparollus (*Euomphalus*) sp.
*gastropod, indet. (cf. *Omphalotrochus*)

F267—(Upper)—
bryozoan, indet.
Composita sp.
terabratuloid brachiopod, indet.

The collections from the Pequop Formation contain little that definitely links them with Permian. The gastropod cf. *Omphalotrochus* suggests Wolfcamp age, but Schaeffer's notes indicate fusulinid control in that portion of the sequence."

Age and correlation. — Based on fusulinid evidence, Steele (1959b) has dated the formations of the undifferentiated sequence of Pennsylvanian and Permian age in the Silver Island Mountains as follows: Strathearn Formation as middle Virgilian to lower Wolfcampian; Riepetown Sandstone as upper lower Wolfcampian to lower upper Wolfcampian; Ferguson Springs Formation as upper Wolfcampian; and Pequop Formation as lower Leonardian to lower Guadalupian.

The Oquirrh (upper portion) Formation in the Silver Island Mountains is tentatively assigned a Wolfcampian age.

The Strathearn Formation, Riepetown Sandstone, Ferguson Springs Formation, Oquirrh (upper portion) Formation, and Pequop Formation of the Silver Island Mountains have been correlated by Steele (1959b) with their respective type localities based on lithologic and faunal evidence.

Th clastic-carbonate facies on Crater Island (Anderson, 1957) may be correlative with the Oquirrh (upper portion) Formation. The lower two-thirds of the carbonate facies on Crater Island (Anderson, 1957) is correlated with the Ferguson Springs and Pequop Formations undifferentiated in the Leppy Range. The upper one-third of the carbonate facies, the porcelaenous dolomites, may be a facies of the Oquirrh (upper portion) Formation.

Measured section. — This section was measured by a confidential source. The writer informed the confidential source as to the geographic location and stratigraphic position of the section in exchange for the description of the measured section.

Section of the Strathearn, Riepetown, Ferguson Springs, and Pequop Formations undifferentiated in W1/2 sec. 29, T. 1 N., R. 19 W., Utah; and in S1/2 sec. 22, N1/2 sec. 27, T. 34 N., R. 70 E., Nevada (unsurveyed).

Fault

Pennsylvanian-Permian:

Strathearn, Riepetown, Ferguson Springs ,and Pequop Formations undifferentiated (incomplete):

Unit	*Description*	*Feet*
65.	Limestone (mostly covered) as unit 64 with siltstone beds probable	53
64.	Limestone and siltstone, interbedded (partly covered); limestone, medium- to dark-gray; very fine-crystalline, dense, with some local fine-crystalline; possible clastic limestone with trace of oöiltes, and disseminated bioclastic debris; siltstone, medium-gray; very fine-crystalline calcareous cement, well indurated	57

63.	Limestone, dark-gray; fine-crystalline, slightly silty, dense; occasional bioclastic zones; minor chert	10
62.	Siltstone, brown-gray; calcareous cement; well-indurated	20
61.	Limestone, medium-gray; oölitic; slightly argillaceous; slightly silty; dense; fossil hash, very fossiliferous at base	15
60.	Siltstone, tan-gray; calcareous cement; well indurated; 2 feet of oölitic silty limestone at center	20
59.	Limestone, as unit 61 except oölitic in lower 5 feet; very silty at top	11
58.	Siltstone, as unit 60	14
57.	Limestone, medium- to dark-gray; very fine-crystalline, very dense; very hard, with some fine-crystalline zones	20
56.	Limestone, medium- to dark-gray; very fine-crystalline, slightly silty, with some bioclastic and coarse-crystalline zones; hard; with several thin, light-gray, oölitic limestone beds near center	110
55.	Limestone (90%) and siltstone (10%), interbedded (partly covered); limestone, medium- to dark-gray; fine-crystalline, slightly silty; some local clastic and bioclastic zones; fossils — crinoid, bryozoan, brachiopod?, fusulinid; siltstone, brown-gray; calcareous cement; well indurated	270
54.	Limestone (90%) and siltstone (10%), interbedded; limestone, medium- to dark-gray; fine-crystalline with coarse-crystalline zones; clastic?, locally bioclastic; minor chert; very fossiliferous — crinoid, large (1 by 3 inches) brachiopods, bryozoan?, 2-inch gastropods (*Omphalotrochus?*) at top and bottom, fusulinids; siltstone, as unit 55	130
53.	Limestone (50%) and siltstone (50%), interbedded; limestone, gray-black; coarse- to fine-crystalline; clastic?, locally bioclastic; medium-bedded; minor chert lenses and nodules; fossils — crinoid, bryozoan, fusulinid; siltstone, brown-gray; calcareous cement; well indurated; forms slope	80
52.	Limestone (70%) and siltstone (30%), interbedded; as unit 53	28
51.	Siltstone, brown-gray; calcareous cement; well indurated; forms slope	10
50.	Siltstone (50%) and limestone (50%), interbedded (partly covered); siltstone, as unit 51; limestone, dark-gray, fine-crystalline, dense; forms ledges (3 to 5 feet); slightly fossiliferous — fusulinids, crinoids	32
49.	Siltstone (75%) and limestone (25%), interbedded (partly covered); as unit 50	95
48.	Limestone, dark-gray; fine-crystalline, dense; minor chert nodules to 6 inches; minor brown calcareous siltstone in upper part; local moderate fossil zones — brachiopod, crinoid, bryozoan, colonial coral	27
47.	Siltstone (60%) and limestone (40%), interbedded (partly covered); forms slope; limestone, medium-gray; very fine-crystalline, silty; argillaceous; random fine porosity — approximately 3%; trace dark mica	86
46.	Covered, probably as unit 47	48
45.	Siltstone (60%) and limestone (40%), interbedded (partly covered) siltstone, as unit 47; limestone, dark-gray; very fine-crystalline, dense; fossils — crinoid, solitary coral	25

44.	Siltstone (80%) and limestone (20%), interbedded; siltstone, as unit 47, with random sand grains; limestone, medium-gray; fine-crystalline; argillaceous; very silty	56
43.	Siltstone (75%), limestone (25%), and trace of dolomite, interbedded (partly covered); siltstone, tan medium-gray; calcareous cement; well indurated; sandy, random medium and fine sand grains; limestone, light-gray; silty, argillaceous, clastic?; trace vugular porosity; possible oölitic; dolomite, medium-gray fine-crystalline, dense; partly oölitic	28
42.	Sandstone, tan; fine-grained; calcareous cement; abundant silt in matrix; random medium grains, grains — quartz, subrounded	7
41.	Siltstone, tan medium-gray; calcareous cement; sandy; well indurated; thin-bedded; slabby; forms slope	22
40.	Limestone, medium-gray; fine-crystalline, slightly silty, recrystallized?, clastic? dense; abundant fossils — bryozoan, crinoid	6
39.	Siltstone, as unit 41	15
38.	Limestone, dark gray-black; very fine-crystalline, slightly silty; local chert nodules (2 to 5 inches); fossil hash, forms ledge	13
37.	Siltstone, medium-gray; calcareous cement; well indurated, hard, dense; forms slope	33
36.	Siltstone (80%) and limestone (20%), interbedded; siltstone, brown-gray; calcareous cement; well indurated, very hard, dense; massive; forms slope; limestone, medium- to dark-gray, very fine-crystalline, slightly silty; minor chert; fossil hash	75
35.	Limestone (60%) and siltstone (40%), interbedded (partly covered); limestone, medium-gray; fine-crystalline, silty, clastic?; nodular chert throughout with a 10-inch band near top; fossil hash — brachiopod and crinoid; siltstone, brown-gray; calcareous cement; well indurated, hard, dense; massive; forms slope	55
34.	Limestone (60%) and siltstone (40%), interbedded; limestone, medium-gray; fine- to medium-crystalline, silty, dense; abundant 4-inch chert bands in upper 20 feet, forms ledges; massive; fossiliferous throughout — abundant fossil hash upper one-half, solitary corals near center of unit, brachiopod and crinoid debris throughout, fusulinids decreased to small amount, large productid (2½ inches) near top; siltstone, medium gray; calcareous cement; well indurated, hard, dense; massive; fossiliferous; forms slope	145
33.	Limestone, medium-gray; silty, very fine-crystalline, clastic?, very silty in lower 5 feet, 1-foot bioclastic zone near center; abundant chert nodules upper one-half; abundant fossils throughout — concentration of large brachiopods (2⅓ inches maximum)	20
32.	Limestone (70%) and siltstone (30%), interbedded; limestone, medium-gray; fine-crystalline, silty clastic?; brown chert nodules to 2 inches; fossils locally abundant — echinoid spines, fusulinids, several small concentrations of colonial? corals; siltstone, medium-gray; calcareous cement; very well indurated; medium-bedded	68
31.	Dolomite, light-gray; dense	5

30.	Limestone (70%) and sandstone (30%), interbedded; limestone, medium-gray; fine-crystalline, silty; sandstone, medium-gray, very fine-grained; calcareous cement; very well indurated	44
29.	Dolomite, light-gray; dense	7
28.	Limestone and sandstone, interbedded; as unit 30	13
27.	Limestone, medium- to dark-gray; medium-crystalline; clastic?, slightly silty; fossil hash — crinoid, fusulinid, echinoid spines, brachiopods	27
26.	Siltstone (65%) and limestone (35%), interbedded; siltstone, medium-gray; calcareous cement; well indurated; fossil debris — crinoids	48
25.	Limestone, dark-gray; very fine-crystalline, clastic?, locally bioclastic, slightly silty; some irregular chert nodules; very fossiliferous — abundant crinoids, fusulinids, echinoid spines, brachiopods	20
24.	Sandstone, medium-gray; very fine grained, grains — quartz, subangular to subrounded; calcareous cement; very well indurated; weathers to slope; fossils — echinoid spines, middle to upper Wolfcamp fusulinids	27
23.	Limestone, medium-gray; fine- to medium-crystalline, slightly silty, abundant thin silty and sandy beds to 5 inches; some random chert; forms ledges; fossil hash — brachiopods, abundant fusulinids, crinoids	50
22.	Siltstone, medium-gray; calcareous cement; very well indurated, hard; grades up into silty limestone; forms slope; fossils — middle Wolfcamp fusulinids	14
21.	Limestone, dark-gray; fine-crystalline; weathers massive, rough; fossils — fusulinids, crinoids, corals	18
20.	Limestone and siltstone, interbedded; limestone, medium-gray; fine-crystalline, very silty; fossils — fusulinids, bryozoan; siltstone, brown-gray; calcareous cement; well indurated	18
19.	Limestone (50%) and siltstone (50%), interbedded (partly covered, 50%); limestone, dark-gray; fine-crystalline, slightly silty, fossils — bryozoan, fusulinid?, crinoid; siltstone, brown-gray; sandy; calcareous cement; well indurated; thick-bedded	73
18.	Limestone, medium-gray; very fine-crystalline; fossil hash — crinoid, echinoid spines, concentrated in 2-inch zones	10
17.	Limestone (50%) and dolomite (50%), interbedded limestone, medium-gray, fine- to medium-crystalline, silty; dolomite, tan-gray; very fine-crystalline, slightly silty; argillaceous; calcareous cement; thick-bedded	25
16.	Limestone, medium-gray; fine-crystalline, clastic, silty; forms ledges; fossils — middle Wolfcamp fusulinids at base	12
15.	Limestone, medium- to dark-gray; fine- to coarse-crystalline, clastic?, very silty; weathers to slope with a few 2-foot interbeds of ledge-forming limestone, medium-gray; very fine-crystalline, silty; well indurated; fossils — abundant fusulinids, crinoid fragments	45
14.	Limestone, medium- to dark-gray; fine-crystalline, slightly silty; fossils — crinoid fragments middle Wolfcamp fusulinids at top	10

13.	Siltstone, brown-gray; calcareous cement; siliceous; slightly indurated; Fe staining; hard slope former; 2 feet of conglomerate at base	13
12.	Limestone, medium brown-gray fine-crystalline, silty; with 1 foot of dolomite, medium- to light-gray; dense; thin-bedded	22
11.	Limestone (50%) and siltstone (50%), interbedded (partly covered, 50-60%); limestone, medium- to dark-gray; fine-crystalline; dense, slightly silty; siltstone, medium-gray; weathers brown; calcareous cement; fair induration	60
10.	Conglomerate; chert and limestone pebbles, mostly small subangular to subrounded, a few large (to 4 inches) rounded pebbles, pebbles aligned parallel to bedding; matrix, gray, silty to clastic limestone	7
9.	Limestone, medium-gray; very fine-crystalline; very dolomitic, slightly silty; with thin zones clastic and very silty limestone to 6 inches	35
8.	Limestone, medium gray-brown; very fine-crystalline, slightly silty, dense; some small dark chert blebs; weathers to slope and ledge	21
7.	Dolomite, brown; fine-crystalline, slightly silty, dense; some pin point and fine vugular porosity; occasional dolomitic limestone; fossils — middle Wolfcamp fusulinids	20
6.	Conglomerate, brown-gray; gray chert pebbles (1/4 to 1 1/2 inches), large ones subrounded, small subangular, pebbles roughly aligned parallel to bedding; matrix, pink silty limestone	6
5.	Siltstone, gray-brown; dolomitic; dense, well indurated; grading up into conglomerate	27
4.	Limestone, medium-gray; fine-crystalline; somewhat siliceous; and conglomerate; chert granule-angular, well cemented, abundant secondary calcite and quartz around granules	37
3.	Covered, scattered outcrop and float indicate limestone as unit 2; fossils — middle Wolfcamp fusulinid near base	80
2.	Limestone (partly covered, 30%), medium-gray; fine-crystalline, slightly silty; locally dolomitic	48
1.	Conglomerate, brown-gray; chert pebbles, chert — gray pebbles (1/4 to 1 1/2 inches), large pebbles — subrounded, small ones subangular to angular, pebbles roughly aligned parallel to bedding; matrix, pink, silty limestone; weathers brown; upper 18 inches pebble-granule conglomerate grading up into limestone	6
	Total Strathearn, Riepetown, Ferguson Springs, and Pequop Formations undifferentiated (incomplete)	2,552+

Angular Unconformity

Pennsylvanian:

Ely Formation:

Upper member.

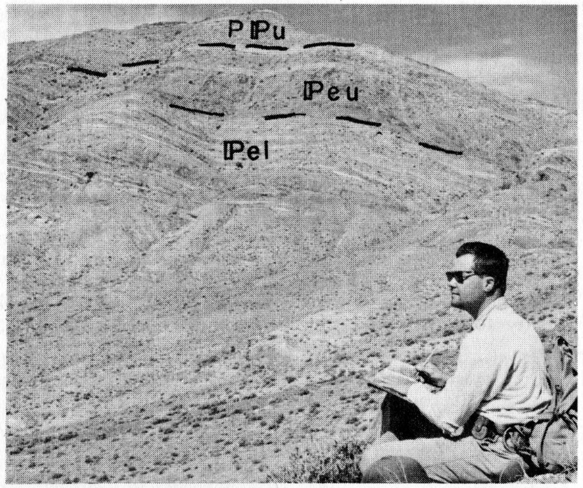


Fig. 14. View looking northwest, Rishel Peak in background. IPel, Lower member of Ely Formation; IPeu, Upper member of Ely Formation; PIPu, Strathearn Formation, Riepetown Sandstone, Ferguson Springs Formation and Pequop Formation undifferentiated (photograph by Albert Young).

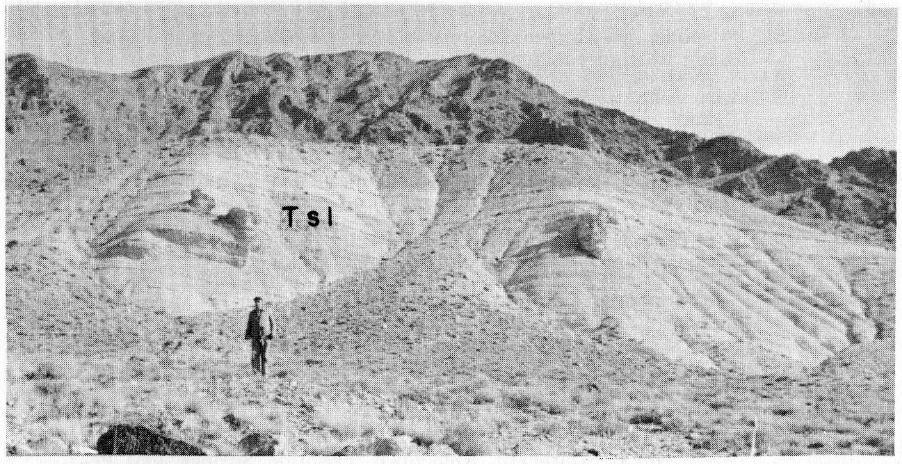


Fig. 15. View looking east, Jenkins Peak at center of ridge in background. John Costain standing on Bonneville level in front of wave-cut cliff in Salt Lake Group, Tsl.

TERTIARY SYSTEM

In the Silver Island Mountains the Tertiary System is represented by the Salt Lake Group, at least 2,800 feet thick; a series of lava flows which aggregate 1,600 feet; and possibly by numerous intrusions.

The igneous rocks are discussed in a separate section of this guidebook.

Salt Lake Group

History of nomenclature. — The name Salt Lake Group was applied by Hayden (1869, p. 92) to the Tertiary marls, sands, and sandstones in Salt Lake and Weber Valleys. He assigned the Salt Lake Group a late Tertiary age and recorded a maximum thickness of 1,200 feet.

The particular beds described by Hayden (1869, p. 92) as Salt Lake Group are now referred to as the Norwood Tuff (Eardley, 1944) of latest Eocene age (Gazin, 1959). However, Hayden's definition also included beds in Salt Lake Valley and the name Salt Lake Group is still retained for those beds which are younger than the Norwood Tuff and older than the Pleistocene.

Slentz (1955) applied the term Salt Lake Group to all the rocks that are post-Wasatch (Paleocene and Eocene) and pre-Pleistocene in age. Slentz (1955) subdivided the Salt Lake Group into the following units which are given in order of ascending age: Traverse Volcanics and Jordan Narrows (white marlstone) units, Camp Williams (mudstone and siltstone) unit, Travertine unit, and the Harkers Fanglomerate unit.

Mapel and Hail (1956, p. 1) have studied the sedimentary and pyroclastic rocks exposed in the Goose Creek district, Utah, and have assigned them to the Payette (?) and Salt Lake Formations. These formations are assigned a Miocene and early Pliocene age, respectively, by Mapel and Hail (1956, p. 1). It appears to the writer that the Salt Lake Group in the Salt Lake Valley is the time equivalent of the combined Payette and Salt Lake Formations as used by Mapel and Hail (1955).

A brief discussion of the Humboldt Formation is presented since the basins of deposition of the Salt Lake Group and Humboldt Formations appear to be closely related.

Sharp (1939) defined the Humboldt Formation in the vicinity of Elko and Wells in northeastern Nevada from exposures of at least 5,000 feet of fluviatile, lacustrine and pyroclastic deposits of Miocene and possibly Pliocene age. He divided the Humboldt into three members: a lower member, mostly lake beds; a middle member, characteried by ash and tuff beds; an upper member, mostly stream-laid deposits.

Van Houten (1956) has reported on the Cenozoic rocks of Nevada. He states:

> "The most extensive and widely exposed sequence of Cenozoic sedimentary rocks in Nevada is late Miocene to early and middle Pliocene in age. These deposits comprise as much as several thousand feet of soft gray to cream-colored unaltered vitric tuff and reworked ash, interbedded with drab bentonitic mudstone, and subordinate amounts of yellowish to greenish gray sandstone and cream-colored limestone, as well as Paleozoic pebble conglomerate developed essentially as a coarse basin-margin facies."

Van Houten (1956) refers to the above sequence of rocks as the vitric tuff unit. In fig. 5 (p. 2814) of the same paper he shows this unit to be present in the Wendover area.

Salt Lake Group terminology is used for the Tertiary sedimentary sequence in the Silver Island Mountains. Van Houten has suggested the use of this terminology in written communication to Donald Blue, who is presently mapping the Pilot Range immediately west of the Silver Island Mountains.

Distribution. — The Salt Lake Group is exposed along the northwestern margin of the range. Exposures are best represented on the west side of Silver Island, on the west side of the northeastern portion of the Leppy Range, and on the west side of the southwestern portion of the Leppy Range.

Character and thickness. — The Salt Lake Group in the Silver Island Mountains consists of the following interbedded lithologies: fissile to massive, yellow-green ,vitric tuff which weathers white to yellow; fissile to platy, tuffaceous, calcareous orange, green, tan and white siltstone; fissile to platy, orange-tan, greenish-tan, and white claystone; and Paleozoic-pebble conglomerate (see fig. 15).

The exposed sqeuence of Tertiary sedimentary rocks aggregates approximately 2,800 feet. However, since the base is not exposed and the top is eroded a considerably larger thickness of Tertiary sedimentary rocks is probably present under the basin fill in the area of the Silver Island Mountains.

Stratigraphic relations. — The Salt Lake Group rests with an angular unconformity upon Paleozoic rocks. Volcanic breccia overlies the Salt Lake Group with an angular unconformity.

Paleontology. — Dwight W. Taylor of the Paleontologic and Stratigraphic Branch of the United States Geological Survey identified the following fauna collected by the writer from the Silver Island Mountains (1958, written communication).

"F174—North end Leppy Range (sec. 32, T. 2 N., R. 18 W.).
Freshwater snails:
Lymnaeidae indet.
Planorbidae indet.

F317—North end Leppy Range (sec. 32, T. 2 N., R. 18 W.).
Freshwater clam:
Pisidium or *Sphaerium*
Freshwater snails:
Valvata
Viviparus referable to *V. turneri* Hannibal
Carinifex

F318—North end Leppy Range (sec. 32, T. 2 N., R. 18 W.).
Freshwater clam:
Sphaerium
Freshwater snails:
Viviparus turneri Hannibal
Carinifex

F330—Southwest side of Silver Island, Silver Island Mountains (unit 26)
Freshwater clam:
Sphaerium

The fossils from localities F174 and F330 are not well enough preserved to be diagnostic of age. The material from localities F317 and F318 is also poor, but there are more species to give a suggestion of age. These two collections are probably early Pliocene, as judged by the *Carinifex* and *Viviparus.*

Viviparus turneri is so far known only from late Miocene and early Pliocene deposits in the northern Great Basin area. *Carinifex* is known from the mid-Tertiary to Recent, but this species seems to be more similar to the geologically younger forms. Middle Pliocene assemblages from the Goose Creek area, Nevada-Idaho, are unlike the present association of species, and hence this collection is probably not that young."

Age and correlation. — On the basis of faunal evidence the Salt Lake Group in the Silver Island Mountains is early Pliocene in age.

The Salt Lake Group is correlated with its type area based on lithology, fauna, and stratigraphic position. It is also correlated with the vitric tuff unit of Van Houten on the same evidence as above. The Salt Lake Group in the Silver Island Mountains is also the lithogenic correlative of a part of the Humboldt Formation.

Measured section. —

Section of the Salt Lake Group in sec. 13, N1/2 sec. 14, T. 2 N., R. 18 W.; and SW1/4 sec. 18, T. 2 N., R. 17 W. (unsurveyed).

Tertiary:

Pliocene:

Eroded top

Salt Lake Group (incomplete):

Unit	*Description*	*Feet*
53.	Conglomerate, as unit 49	60
52.	Siltstone, very light-green to white, becoming yellow-green towards top of unit; fissile to platy; oölitic at top of unit; forms cliff	39
51.	Tuff, white to very light yellow-white; weathers light orange white	2
50.	Claystone, light greenish-tan to white; weathers light greenish white; fissile to platy; oölitic at top; forms cliff	17
49.	Conglomerate; matrix of tuffaceous siltstone, light-tan to white; pebbles and cobbles, blue-black; weather purple-black; pebbles are Paleozoic limestone; 1/8 to 4 inches (average 1/2-inch)	1
48.	Claystone and siltstone, interbedded; siltstone, light olive-tan; calcareous; oölitic; claystone, white to light-tan; weathers white to light orange; siliceous, ferruginous staining; fissile to platy; forms cliff	25
47.	Tuff, light olive-tan; calcareous; massive; forms cliff	22
46.	Siltstone and claystone, interbedded; siltstone, light olive-tan, white; calcareous, tuffaceous; oölites; fissile to platy claystone, white to light-gray; forms cliff	46
45.	Claystone, light orange-tan; weathers light to medium orange tan; siliceous	2
44.	Siltstone, as unit 46	51
43.	Covered	570
42.	Siltstone and claystone, interbedded; siltstone, white; weathers white to medium orange; calcareous, tuffaceous; claystone, white to light orange; weathers white to medium orange brown; conchoidal fracture, translational ripple marks; varves; fissile to thin-bedded, forms slope	156
41.	Claystone, light-orange to white; calcareous; fissile to very platy; uniform throughout; forms slope	82
40.	Marl and siltstone, light yellow-green-white; platy to thin-bedded; marl is at top of unit; siltstone is speckled with orange; forms slope	15
39.	Tuff, white; weathers white to light orange; glass shards; forms cliff	22
38.	Siltstone and claystone, interbedded; as unit 42 except fissile to platy	89
37.	Claystone, white to very light-gray; forms slope	118
36.	Siltstone, light- to medium-orange; platy	3
35.	Claystone, very light-gray; extremely fissile	4
34.	Claystone, light yellow-green-white; platy; varves	2
33.	Siltstone, very light yellow-white; calcareous; fissile to platy; and a 1 foot bed of sandstone, medium orange-brown; fine-grained, angular; calcareous; light and heavy minerals; forms slope	82
32.	Tuff, very light orange-tan; weathers light tan orange, fissile to thin-bedded; glass shards; forms slope	48
31.	Covered	99
30.	Siltstone, very light-gray to light-orange; siliceous; fissile to platy; forms slope	41
29.	Covered	52
28.	Tuff; light yellow-white; weathers light orange white; glass shards; thin-bedded; forms slope	26
27.	Tuff, light yellow-white; glass shards; fissile; forms slope	91
26.	Siltstone, light yellow-white; weathers very light yellow green white; calcareous; fissile to platy; forms slope; fossils — *Sphaerium* at top of unit	36
25.	Tuff, light-green to light-orange; platy to thin-bedded; varves; cross-bedded; glass shards; forms cliff	18
24.	Covered	206
23.	Tuff and siltstone, tuff, light-green; glass shards; cross-bedded; poorly consolidated; siltstone, very light-green; tuffaceous; fissile to platy; forms slope	33
22.	Tuff, light orange-white silty; glass shards; fissile to platy; forms slope	14
21.	Tuff, siltstone, and quartzite; tuff and siltstone as unit 23; quartzite, light green; fine-grained; 1 foot beds occasional; forms slope	155
20.	Tuff, medium yellow-green; weathers white to yellow; glass shards; poorly consolidated	3
19.	Siltstone, very light-green; tuffaceous; fissile to platy; forms slope	13
18.	Tuff, as unit 20	3
17.	Siltstone, as unit 19	31
16.	Siltstone, light yellow-tan; weathers light yellow to white; calcareous; fissile; forms slope	23
15.	Siltstone	24
14.	Claystone, light-green; weathers white to light green; varves; thin-bedded	1
13.	Siltstone, as unit 19	5
12.	Claystone, as unit 14	1
11.	Siltstone, light tan-green; weathers light yellow green; calcareous; varves; very platy	1
10.	Tuff, medium-orange to white; weathers white to light orange; glass shards; thin-bedded; poorly consolidated	2
9.	Siltstone, very light-green; calcareous, tuffaceous; fissile to platy; forms slope	39
8.	Chert, maroon, purple, pink, medium orange-tan; weathers medium to dark orange tan; platy, base of unit has conchoidal fracture; top of unit contains relic varves; forms ledge	3
7.	Siltstone, as unit 6	256
6.	Tuff and siltstone, interbedded; tuff, white; glass shards; thin- to medium-bedded; siltstone, medium green; weathers light green; calcareous; tuffaceous; fissile to platy; forms slope	14
5.	Siltstone, medium orange-white calcareous; tuffaceous; fissile to platy 6-inch chert seam at base; light maroon; weathers banded pink and maroon; forms slope	69
4.	Claystone, light-green, platy; conchoidal fracture; forms slope	42
3.	Siltstone, medium-orange; weathers light orange; platy to medium-bedded; conchoidal fracture; forms ledge	37
2.	Tuff, medium orange to white; glass shards; poorly consolidated	5
1.	Chert, medium tan-purple, weathers medium tan	1
	Total Salt Lake Group (incomplete)	2,800

Base not exposed.

QUATERNARY SYSTEM

General statement. — The Quaternary in the Silver Island Mountains consists of the following: Lake Bonneville lacustrine deposits, playa lake deposits, alluvial fan deposits, other fluvial deposits, eolian deposits, desert pavement deposits, and talus deposits.

Lake Bonneville lacustrine deposits. — The terraces of Lake Bonneville are everywhere present in the Silver Island Mountains. A plane table and alidade survey was conducted by the writer and J. Costain to ascertain the elevations of the main terrace levels. The elevations in feet above sea level and the names of the terrace levels, where correlated with Eardley and others (1957), are as follows: 5204 — Bonneville; 5123; 5075; 4953 — Rush Valley arm; 4834 — Provo; 4714; 4484 — Stansbury (Utah Valley arm); 4251 — Gilbert.

The terrace levels are well marked with calcareous tufa deposits, and beach bars across embayments are often continuous with these levels. The various shapes of these deposits are described in the section dealing with geomorphology.

Nearshore Lake Bonneville sediments consist of poorly cemented gravel, sand, silt, diatoms, oölitic sand and well indurated calcareous tufa. The deposits contain an abundance of ostracods.

The diatomaceous deposits are especially abundant between the Provo and Stansbury levels as previously reported by Anderson (1957, p. 111). These deposits which are white in color, can be seen in abundance in the canyons along the southeastern margin of the Leppy Range.

Playa lake deposits. — Playa lake deposits are present throughout the Great Salt Lake Desert which surrounds the Silver Island Mountains with the exception of the southwestern extremity of the range. These playa lake deposits are restricted to a zone near the surface. The deeper dark brown to black clays encountered by the drill (Nolan, 1927) belong to a period of continuous lake deposition by Lake Bonneville, as previously mentioned by Anderson (1957, p. 119).

The two main types of playa lake deposits are underclay and crystalline salt crusts. They are mapped as Qc and Qs, respectively, on the geologic map of the area (pls. 1A and 1B).

Anderson (1957, p. 119) has described the underclay as a fine calcareous clay which in fresh exposures is light gray to cream colored and extremely plastic. Interbedded sand lenses occur in all proportions in the clays and are limited to nearshore localities (Nolan, 1927). As the crystallien sale crusts are approached toward the Bonneville basin the underclay

is covered with a thin salt coating. The roughness of the salt coating is explained by Nolan (1927) to be due to the development of miniature thrust faults during the expansion attendant upon crystallization.

There are two areas of crystalline salt crusts adjacent to the Silver Island Mountains. They are the Bonneville salt flat on the southeastern margin of the range and the Pilot Valley salt crust on the northwestern margin of the range. Nolan (1927) estimated the Bonneville salt flat to cover an area of 150 square miles and the Pilot Valley salt crust to cover an area of 25 square miles. Eardley and others (1957) have calculated a total of 329,000,000 tons of salt in the Bonneville salt crust and 23,000,000 tons of salt in the Pilot Valley salt crust. Anderson (1957, p. 121) has previously reported the salt as a white, extremely porous, coarsely crystalline aggregate.

Alluvial fan deposits. — A large number of alluvial fans can be seen along the southeastern margin of the range where they have debouched from the mountain range into the Great Salt Lake Desert. These deposits originated and attained their greatest thickness prior to the advent of Lake Bonneville as the lacustrine deposits and terrace levels of Lake Bonneville veneer and notch, respectively, the alluvial fan deposits.

Other fluvial deposits. — Channels cut in the Salt Lake Group along the west side of Silver Island above the Bonneville level are veneered with conglomerate and sandstone which dips toward the basin, opposite to the dip of the Great Salt Lake Group. These consolidated fluvial deposits were possibly laid down by a tributary of a Pleistocene lake older than Lake Bonneville.

Eolian deposits. — Sand dunes composed of quartz and feldspar are accumulating along on the west side of the northeastern extremity of the Leppy Range. The source area is probably the lava flows which are abundant in this area.

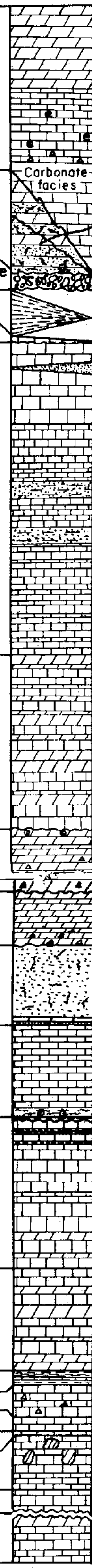
Mound-shaped dunes are also being built on the west side of Floating Island. They contain silt and their source area is thought to be the Great Salt Lake Desert.

Desert paevment deposits. — The veneer of lag gravels on the pediment along the west side of Silver Island has been winnowed out producing desert pavement deposits on the surface of the pediment. The source material for the lag gravels is the slope wash from the mountain range which has been reworked by Lake Bonneville and reworked again by slope wash.

During April, 1956, winds at a velocity of 83 miles per hour were reported, over the radio, as measured at the Wendover Air Force Base. This suggests how pavement deposits are formed in this area.

Talus deposits. — Throughout the mapped area numerous talus deposits have been formed. These deposits are typical in arid climates such as the Silver Island Mountains.

FIGURE 16



System	Formation	Thickness	Description
PERMIAN	Permian undifferentiated	1808'	Light to dark gray and bluish-gray fusulinid and crinoidal limestone, thin-bedded to massive, with dark chert beds and lenses in lower part; upper one-third is gray, aphanic dolomite that weathers brown.
? PENN.?	Unnamed formation	Clastic-carbonate facies	Brownish-gray quartzite grading upward into medium gray dolomite; weathers brown, forms blocky ledges and slopes. — Unconformity —
			— Unconformity —
	Diamond Peak conglomerate	90'	Grayish-brown to purple and dull white chert and quartzite pebble conglomerate. — Unconformity —
?	Chainman shale	0-309'	Purplish-gray and yellowish-brown, fine to coarse-grained fissile siltstone; upper half has interbedded bluish and brownish-gray silty quartzite, thin to medium-bedded; siltstone diminishes upward.
MISS.	Madison limestone	0-35'	Dark gray to black crinoidal limestone, fragmental, coarse-grained. — Unconformity —
DEVONIAN	Guilmette formation	Estimated 550' Measured 1552'	Light to dark gray, aphanic to fine crystalline, thin-bedded to massive limestone, with some contorted beds that are reddish-orange on parting planes; two thick purplish-brown calcareous siltstone units in middle portion; abundant stromatoporoid and some Stringocephalus in upper part; limestone units form ledges or cliffs; siltstone units form steep slopes.
	Simonson formation	1176'	Interbedded and banded, light gray to black, aphanic to medium crystalline, mainly thin and medium-bedded dolomite, calcareous dolomite, dolomitic limestone, and limestone; calcareous dolomite and limestone predominate; weathers to step-like slope; some beds have uneven surfaces due to primary deformation; biostrome of huge stromatoporoid in lower part; Stringocephalus biostrome in middle part. — Unconformity —
SIL.	Laketown dolomite	534'	Light to dark gray, very fine to medium crystalline, thin-bedded to massive calcareous dolomite; vuggy, dark chert beds in lower two-thirds; lower unit [illegible] — Unconformity —
ORDOVICIAN	Fish Haven dolomite	372'	Medium gray to black, fine to medium crystalline, thin-bedded to massive calcareous dolomite; chert nodules in lower part. — Unconformity —
	Eureka ? quartzite	542'	Light grayish-white, vitreous, blocky, thin-bedded to massive quartzite; basal unit is a thin sandy quartzite and a dark gray, calcareous dolomite; upper half of ~~quartzite has~~ dark brown, sandy inclusions; and light and dark gray banding.
	Lehman - Kanosh ? fm	637'	Light bluish and brownish-gray limestone with thin, contorted bedding and rusty-brown mottling common; lower unit is dark brown to black, fossiliferous argillite.
	Garden City limestone	1020' +	Bluish-gray, thin to thick-bedded, mottled and banded limestone; tan weathering dolomite in lower part; thin intraformational conglomerate beds in upper one-third; forms ledges and slopes; upper contact faulted in measured section.
CAMBRIAN	Upper Cambrian undifferentiated	688'	Brownish and bluish-gray, thin-bedded to massive limestone and dolomite; some beds laminated; forms ledges and step-like slopes; white "twiggy" markings common.
Middle Cambrian	Dunderberg shale	80'	Thin, interlayered light gray to reddish-brown limestone, shale and chert.
Middle Cambrian	Weeks limestone	208'	Light gray to bluish-gray limestone; some chert and secondary dolomite.
Middle Cambrian	Marjum limestone	111'	Bluish-gray limestone; some brown banded units; forms slopes and ledges.
Middle Cambrian	Wheeler shale	32'	Interbedded bluish-gray limestone and red to yellowish-brown shale.
Middle Cambrian	Swasey limestone	406'	Bluish and brownish-gray, very fine crystalline, thin-bedded to massive limestone; forms slopes and ledges; dolomitized patches in upper unit.
Middle Cambrian	Dome limestone	157'	Light gray, medium to coarse crystalline, massive dolomitic limestone.
	Cambrian ?	343'	Medium to dark gray, thin-bedded to massive limestone; upper unit is gray dolomite in fault contact with Dome limestone; highly faulted, brecciated, and jointed; forms ledges; some brown mottling in lower part.

Scale: 0 500 1000 1500 2000 feet

STRATIGRAPHIC SECTION

OF THE

NORTHERN SILVER ISLAND MOUNTAINS

WARREN L. ANDERSON

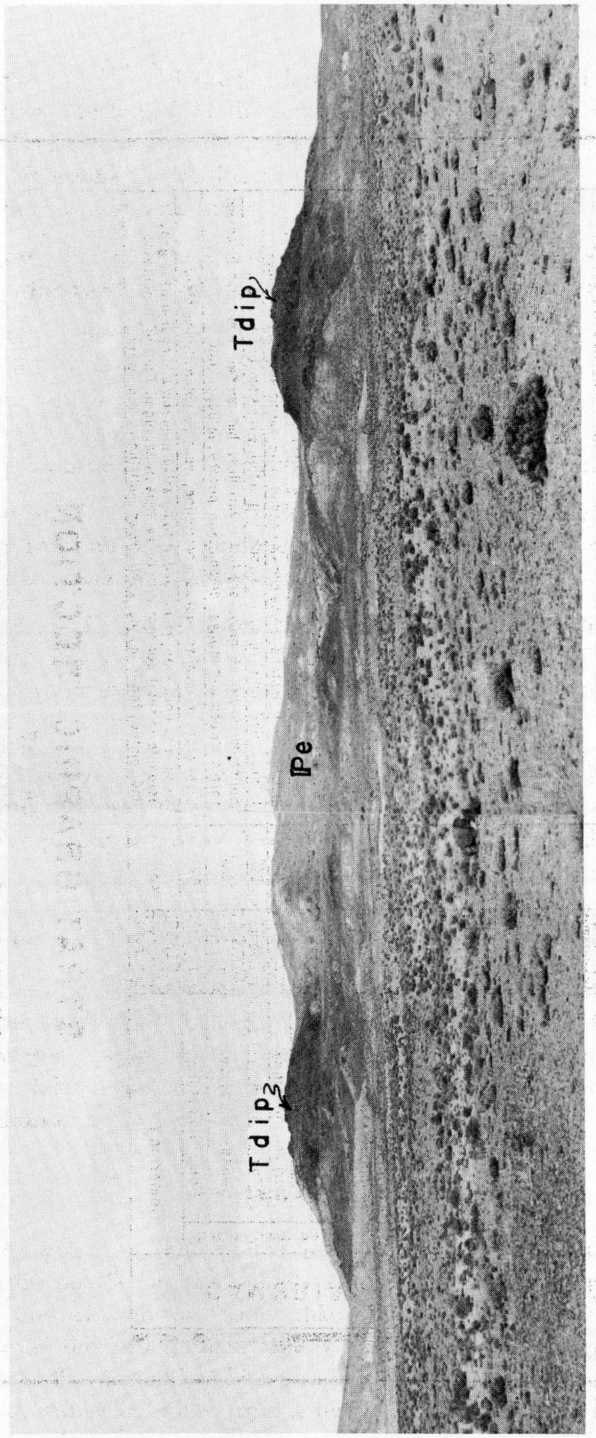


Fig. 17. View looking east in eastern portion of Leppy Range. Diorite porphyry, Tdip, intruded into Ely Formation, ℙe.

IGNEOUS ROCKS OF THE NORTHERN SILVER ISLAND MOUNTAINS

By

Warren L. Anderson

INTRUSIVE ROCKS

Stocks

General character. — Probably during pre-Miocene time, sedimentary rocks in what is now the northern Silver Island Mountains were intruded by granitic rocks. The intrusive rocks consist of four stocks (see fig. 2A); South stock, Crater Island stock, Sheepwagon stock, and North stock, and minor igneous outcrops of the same general composition that are separate from the main stocks but genetically related to them.

These igneous intrusives are the cause for slumping, distortion, and local overturning of the sedimentary beds near their contacts.

Two large xenoliths were obesrved: one in granodiorite on Desolate Point, and another in granodiorite of the Sheepwagon stock.

Generally speaking, the igneous rocks in the stocks on Crater Island grade from one rock type to another, which is to be expected in igneous masses where sedimentary rocks of different compositions have been intruded. The igneous rock types observed in thin-sections were syenite, quartz monzonite, and granodiorite, which were differentiated from each other with minor differences in percentage composition of quartz, feldspathoid, and potash and plagioclase feldspars.

Age. — The exact age of the stocks cannot be determined, because there are no Mesozoic or Cenozoic rocks present to show age relationship. A pre-Miocene age is probable, because joints judged to be caused by structural forces during Mio-Pliocene time are prominent in the stocks. Also one small fault, probably of the same age as the joints, appears to extend into the north side of the Crater Island stock.

According to Sharp (1939), the Ruby-East Humboldt Range in eastern Nevada (a typical mountain range in the Basin and Range province), contains pre-Miocene igneous rocks. Eardley (1951, p. 310) states that the plutons east of the Idaho Batholith were formed during a middle or late phase of the Laramide orogeny (Paleocene-Eocene), and igneous intrusives in the Basin and Range province, including the Silver Island Mountains, could have been emplaced during the same time period. Nolan (1935) assigns a late Eocene to early Oligocene age to the quartz monzonite stock in the Gold Hill area.

Crater Island stock. — Crater Island stock covers approximately two square miles and is the largest of the igneous intrusives in the mapped area. Several thin-section samples of the stock show it to be composed of quartz monzonite and monzonite that locally grade into syenite and locally are rich in biotite, hornblende, and augite.

Especially prominent in the Crater Island stock is the northeast-southwest joint set that is discussed under "joints" in the section on structure.

South stock. — South stock is of the same composition as the Crater Island stock, although rocks of the South stock generally are richer in biotite, hornblende, and augite content. Since the two stocks are separated by only a small neck of alluvium, there is little doubt that at a short depth beneath the surface they are interconnected and thus are one and the same stock.

Sheepwagon stock. — This stock, near the northern tip of Crater Island, derives its name from an old, abandoned "Home on the Range" sheepwagon nearby. The composition of this stock is granodiorite.

North Stock. — This stock forms the northern-most tip of Crater Island and of the Silver Island Mountains. The eastern two-thirds of North stock is composed of quartz monzonite and monzonite that grades westward into granodiorite.

Three small islands or buttes about 500 yards northeast of North stock (see pl. 2A) are composed of granodiorite. The presence of granodiorite on three sides of the principal part of North stock which is composed of monzonite and quartz monzonite suggests that all of the northern intrusives in the range are part of one continuous stock that has a center portion of monzonite and quartz monzonite that grades outward into a halo of granodiorite.

Desolate Point. — This point on southeast Crater Island that so well deserves its name is not large enough to be classified as a stock. However, it may be the surface exposure of an intrusive of stock-like proportions that is hidden by playa lake deposits. The composition of the intrusive on Desolate Point is granodiorite.

Dikes

General character. — The main igneous dikes in the northern Silver Island Mountains can be classified under four rock types: andesite, aplite, lamphrophyre, and rhyodacite. Some dikes contain local variations, both mafic and felsic, of these rock types. Highly mafic dikes were observed on the west end and near the east end of Sheepwagon stock, and on northwest Crater Island. The dikes range in width from a few inches to about 20 feet, and in length from a few feet to about 600 feet.

The sedimentary rocks in contact with some dikes have been noticeably altered to a ferruginous color.

Only one sill was observed, which was in the undifferentiated Permian on southern Crater Island. Undoubtedly others exist but are not exposed at the surface. Because of the paucity of sills in the mapped area, they will not be discussed further in this study.

Age and structural control. — The age of the dikes is judged to be post-Miocene, probably Pliocene to Pleistocene. This is concluded because: (1) several dikes cut through igneous stocks and thus are younger than the stocks; and (2) dike intrusions generally are along zones of weakness, such as faults and joints, whose age is thought to be Mio-Pliocene.

On northwest Silver Island (see pl. 2A), there are a series of andesite dikes in normal faults along which there has been very slight movement, and in large fractures or joints (observable on aerial photos) that the writer interprets as shear fractures due to a compressive force mainly from the south. These faults and fractures are essentially parallel and strike northeast. Wherever one of the large fractures was encountered in field mapping, the writer invariably found igneous dike rock. In many cases the dike was too small to map. Likewise, most faults in the same area had igneous dike rock somewhere along their strikes.

The influence of this fault pattern extends into southern Crater Island, where andesite and rhyodacite dikes (too small to map) have intruded parts of South stock and the southern part of Crater Island stock, and strike in the same direction as those on northwest Silver Island. These dikes very likely are in the northeast-southwest joint set that is so prominent in that area.

Dikes in the central and northwest parts of Crater Island are generally in essentially north-south normal faults of very slight displacement.

Andesite dikes. — The major part of the dikes are andesite, and these are found on northwest Silver Island and southern Crater Island. Where these dikes intrude the stocks on southern Crater Island, the andesite can be differentiated from the granitic rocks by its darker color, flatter edges, and greater resistance to weathering. On South stock the dike material is widely scattered. This may be due to the erosion of one or more large dikes and/or sills.

One large andesite dike on northwest Silver Island contains limestone xenoliths from an inch to about 18 inches in diameter.

Rhyodacite dikes. — Rhyodacite is a grayish- to greenish- brown dike-rock equivalent of granodiorite. These dikes are present in South stock, on the west side of Crater Island stock, and at various localities along the west edge of Crater Island. Many of the dikes are porphyritic, containing phenocrysts that are mainly plagioclase. The ground mass is plagioclase and orthoclase. Dark minerals present are biotite altered to chlorite and fresh hornblende.

Lamphrophyre dikes. — These dikes are not as numerous as the rhyodacite dikes, but where present their dark green color is easily recognized. They are found in the central part of Crater Island. Generally, the lamphrophyre dikes are less resistant to weathering than the andesite and rhyodacite dikes.

Aplite dikes. — Aplite dikes are especially abundant in and adjacent to the Sheepwagon stock. They are also present but not easily located in the other stocks. The dikes are very small, from a fraction of an inch to about 10 inches in width, and they apparently have intruded the granitic rocks along fractures.

IGNEOUS ROCKS OF THE CENTRAL AND SOUTHERN SILVER ISLAND MOUNTAINS

By

Frederick E. Schaeffer

INTRUSIVE ROCKS

Stocks

Description. — A small granitic stock (about one-quarter of a square mile) is present approximately two miles north of Tetzlaff Peak (see pl. 1B). This stock consists of a granodiorite and a hornblende-rich monzonite facies. The two facies were easily mapped because of the contrast of the light-gray granodiorite against the brownish-black, hornblende-rich monzonite. Granitic dikes which may be apophyses of the stock were observed as distant as two miles (see pl. 1B). One of the dikes is a pegmatitic granodiorite and may represent an additional facies of the granitic stock. The sedimentary cover between the dikes and the stock is commonly converted to marble indicating possible continuity of igneous rocks at depth.

A light-green to black diorite porphyry stock about one-half of a square mile in size is present immediately north of the granitic stock and in contact with it (see pl. 1B). Marbles and hornfelses were formed by the diorite porphyry intrusion.

Age. — The exact age of the stocks is unknown because Mesozoic and early Tertiary strata are not exposed in the range.

The granitic stock is dated as post-Permian and pre-early Pliocene. Lead-alpha age determination of stocks of similar composition in Utah and Nevada 125 to 225 miles distant from the Silver Island Mountains have been made by Jaffe and others (1959). These age determinations range between 37 and 69 million years (Paleocene to Eocene, as noted in Stokes, 1960). Thus the granitic stock in the Silver Island Mountains is tentatively assigned a Paleocene to Eocene age.

The diorite porphyry stock is younger than the granitic stock as evidenced by xenoliths of granitic rock within the diorite porphyry. The diorite porphyry stock is younger than the granitic stock, post-Paleocene-Eocene, and pre-early Pliocene in age.

Dikes

Description. — Throughout the range, dikes of various composition occur along faults. They are especially common in the vicinity of the granitic and porphyry stocks (see pl. 1B). The dikes have granitic and porphyritic textures.

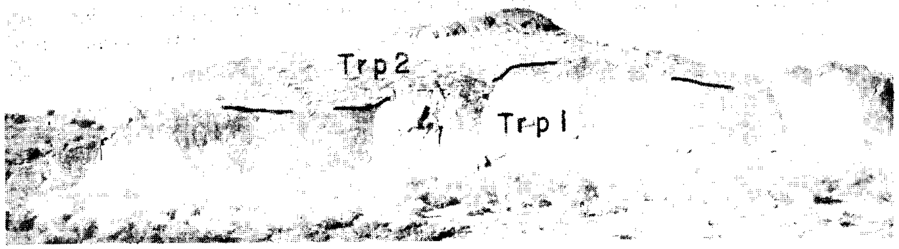


Fig. 18. View looking west near U. S. highway 40 in western portion of Leppy Range. Rhyolite porphyry #1, Trpl. beneath rhyolite porphyry #2, Trp2.

Fig. 19. Post-early Pliocene volcanic breccia, Tvb, in eastern portion of Leppy Range (arrow points to pick).

The granitic dikes, which are similar in color to the granitic stock, are restricted to an area within a two mile radius of it and have the same composition as the stock with the exception of one light red granite dike (see pl. 1B).

White and red rhyolite porphyry dikes are common on either side of Tetzlaff Canyon (see pl. 1B) and are also present along the ridge between Jenkins Peak and Silver Peak (see pl. 1A). Medium grayish-green dacite porphyry dikes are common in the saddle north of Silver Peak, Silver Island, and along the sides of Millard Canyon, Leppy Range. One quartz latite porphyry dike was observed in the eastern portion of the Leppy Range.

Age. — The granitic dikes may have been emplaced concurrently with the granitic stock and are therefore tentatively assigned a Paleocene to Eocene age.

The porphyry dikes may have been emplaced concurrently with the porphyry stock and therefore tentatively younger than the granitic stock, post-Paleocene-Eocene, and pre-early Pliocene in age. A few of these dikes cut igneous rocks which may be part of the early volcanics (early Tertiary?).

EXTRUSIVE ROCKS

Description. — Seven lava flows were mapped in the Leppy Range. These extrusive rocks were distinguished on the basis of color and mineralogical composition. They are as follows: a generally red volcanic breccia with light- to medium-gray, black, red, and light-brown boulders; grayish-red rhyolite porphyry #1 (Nevadite); medium-gray to medium-red rhyolite porphyry #2; light- to medium- gray rhyolite porphyry #3; light reddish-gray to light gray andesite porphyry #1; green-gray, green-red, green-black, black, medium-red, medium-green, andesite porphyry #2; and brick-red pilotaxitic andesite porphyry #3 (see pl. 1B).

Rhyolite porphyry #2 and andesite porphyry #2 probably represent series of flows rather than individual flows. Andesite porphyry #3 is a "marker bed".

A black vitrophyre was observed at the base of rhyolite porphyry #2 in the vicinity of Volcano Peak, eastern portion of the Leppy Range. The black vitrophyre was also observed between andesite porphyry #3 and the volcanic breccia in Silver Island Pass.

Stratigraphic relations. — Since rhyolite porphyry #2 and andesite porphyry # 2 probably represent series of flows, the exact stratigraphic relations between the lava flows are unknown. However, a few general relationships were noted. They are as follows: rhyolite porphyry #2 overlies rhyolite porphyry #1 at some localities and the volcanic breccia at others; rhyolite porphyry #3 overlies rhyolite porphyry #2; andesite porphyry #2 overlies andesite porphyry #1; andesite porphyry #3 overlies andesite porphyry #2 at some localities and the volcanic breccia at others; the volcanic breccia contains boulders which are similar in composition to rhyolite porphyry #2, rhyolite porphyry #3, the black vitrophyre, and the Salt Lake Group.

The general stratigraphic relations between the lava flows and the sedimentary rocks are as follows: volcanic breccia, rhyolite porphyry #2, and andesite porphyry #2 overlie the Salt Lake Group; rhyolite porphyry #1, rhyolite porphyry #2, and andesite porphyry #2 overlie Pennsylvanian and Permian strata.

Age. — Rhyolite porphyry #1 and at least a part of rhyolite porphyry #2 and andesite porphyry #2 dip between 26 and 38 degrees towards the west. If this dip is structural rather than primary then these volcanics belong to an earlier period of volcanism and are designated as the "early volcanics." All of the other volcanics of the range are nearly horizontal or gently dipping. The volcanics which overlie the Salt Lake Group are designated the "late volcanics". The nearly horizontal volcanics which overlie the Pennsylvanian and Permian strata are tentatively assigned to the "late volcanics". If the dip of the early volcanics is primary, then the early and late volcanics are probably closely related in time of origin.

The early volcanics are tentatively dated as post-Permian and pre-early Pliocene. These volcanics may be early Tertiary in age.

The late volcanics are dated as post-early Pliocene and pre-late Pleistocene. Andesite porphyry #3 is the youngest flow of the late volcanics.

STRUCTURAL GEOLOGY OF THE NORTHERN SILVER ISLAND MOUNTAINS

By
Warren L. Anderson

REGIONAL SETTING

The Silver Island Mountains are in the Basin and Range Province that is characterized by north-trending basins and ranges. Eardley (1951, p. 474) quotes Fenneman (1931), who describes the distinctive features of the province as "isolated, nearly parallel mountain ranges (commonly fault blocks) and intervening plains made in the main of subaerial deposits of waste from the mountains. These deposits, although locally absent, are often very deep and are generally unconsolidated".

Gilbert (1874, 1875) first presented the thesis that the ranges of the Basin and Range Province are mountain blocks bordered on one or both sides by profound faults characterized by vertical movement. Later, King (1878) emphasized the idea that the faulting had been superposed on earlier intense folding.

The Basin and Range fault system is recognized to be younger than the Laramide folds and thrusts. The Laramide structures appear to have locally influenced the course of the later Basin and Range faults (Eardley, 1939, p. 1298).

Erdley (1951, p. 485), in discussing the age of the Basin and Range structures, states that Nolan (1943) believes the best conclusion possible from present information is that block faulting, as a process, probably began in early Oligocene time and has been more or less continuous ever since. Eardley notes, however, that topographically expressed faults probably date back only to late Pliocene or early Pleistocene, though there may have been earlier movments along them. He concludes (p. 475) that the faulting took place chiefly in Pliocene and early Pleistocene time, although in places it started earlier and lasted longer, even to the present.

INTRODUCTORY STATEMENT

The Silver Island Mountains trend mainly northeast, with Crater Island at its north end trending north. Fenneman's description of intervening plains fits the mapped area, where playa lake and lacustrine deposits of the Great Salt Lake Desert separate the range from the Newfoundland Mountains to the east and the Pilot Range to the west.

Numerous faults, both high-angle normal and reverse and with throws ranging from a few inches to approximately 4,800 feet, are present in the mapped area. Many faults could not be accurately classified as normal or reverse, because the fault lines have been covered with recent sediments. One strike-slip fault was observed and mapped near the Sheepwagon stock.

A northeast-northwest conjugate joint system is present in the sedimentary rocks, and there is a trend towards a northeast joint set in the igneous stocks.

The exact age of the structures in the mapped area is impossible to establish because of the lack of Mesozoic and Cenozoic formations in the northern Silver Island Mountains.

Structurally, Crater and Silver Islands are different in many ways and therefore are discussed separately.

See geologic cross-sections on plate 2B (vertical scale exaggerated) for further detail.

CRATER ISLAND

General structure. — Crater Island rises rather abruptly on the east side and is tilted westward. Where tilted beds disappear under the unconsolidated sediments of Pilot Valley, dips average about 11 degrees westward, although there are isolated fault blocks that have higher dips.

A complex fault system is present. A large number of faults strike generally north. This includes two major faults of large vertical displacement: Crater Island fault and Sheepwagon fault. Several north-trending faults have very slight or no distinguishable displacement and might be classified as tension fractures. Igneous dike rocks crop out in many of them at various localities along strike.

Several generally east-trending step-faults are present.

West border. — There is no evidence that Crater Island is bounded on the west side by any type of fault. The writer believes that the westward-dipping beds of Crater Island are part of a broad synclinal fold that disappears under the Pilot Valley sediments and appears again in the form of eastward-dipping strata on Lamay Island (see fig. 1), approximately four miles west of the northern tip of the range. This is not to assume, of course, that the fold is continuous without hidden faulting of some degree.

Possible east border fault. — The rather abrupt rise of the east side of Crater Island is one of the physiographic criteria used as evidence for border faults in the Basin and Range province. There is no other suggestive evidence that a fault borders Crater Island on its east side. However, because of the abrupt rise of the east side compared to the slight dip of the west side, it is possible that some sort of east border fault exists, but additional evidence for such a fault is concealed by the sediments of the bordering plain that cover what could be the down-thrown block.

Crater Island fault. — This is a north-trending fault in the central portion of Crater Island. No dips could be obtained, because the fault plane has been covered by recent sediments. The fault is high angle, normal or reverse, with a maximum throw of approximately 1,250 feet.

Sheepwagon fault. — Near the northern end of this fault, where the

only measurable outcrop of the fault plane was observed, the fault dips 82 degrees southwest toward the down-thrown block and strikes slightly northwest, indicating a normal dip-slip fault. Farther south, however, the dip of the strata steepens against the fault on the up-thrown block, which is an excellent indication of reverse faulting. Possibly, where the 82 degree dip was observed, the fault plane could locally curve from high-angle reverse to high-angle normal. Maximum throw is estimated to be 2,200 feet. In the zone of maximum displacement, the Simonson Formation is against the Garden City Limestone.

Summary. — The writer is inclined to believe that the structure of Crater Island involves an earlier period of folding followed by faulting. The folding would involve east-west compression, which also could have caused some reverse faulting. Also, simultaneous north-south tensional forces could be the cause for the east-west step-faults. At a later period, release of compression would result in east-west tensional forces, that could have caused normal faults both large and small, including an east border fault, and the tension fractures on the west side of Crater Island. It must be remembered, also, that intrusion of the igneous stocks on Crater Island prior to the period of faulting played no small part in making the structure complex.

NORTHERN SILVER ISLAND

General structure. — On northern Silver Island, the block north of the Lost Canyon fault is the most structurally complex. Dips of the strata range from as high as 83 degrees north, immediately adjacent to the Lost Canyon fault, to 19 degrees north, where the strata disappear under the alluvium at the northern-most tip of Silver Island. On the west side, dips are as low as 15 degrees north. The majority of the faults strike north-east. This includes a series of essentially parallel fractures and small faults that strike northeast and are more or less parallel with the northeast joint set in that area. These are further described in the sections on joints and igneous dikes. A smaller number of faults strike northwest. With the exception of the Lost Canyon fault, fault throws range from a few feet to about 600 feet. All faults observed are very high angle normal, except for five northwesterly-striking reverse faults of very slight vertical displacment and horizontal extent.

In the area south of the Lost Canyon fault the rocks dip steeply toward the fault.

Lost Canyon fault. — This is the main structural feature on northern Silver Island and is easily recognized from the roads on either side of the island. Gray, somewhat brownish-weathering limestones, and thin, interbedded cherts and conglomerates of the Permian undifferentiated have been faulted against generally darker gray carbonate rocks of the Simonson and Guilmette Formations of Devonian age. A large fault valley is present along the strike of the fault on the west drainage side of Silver Island.

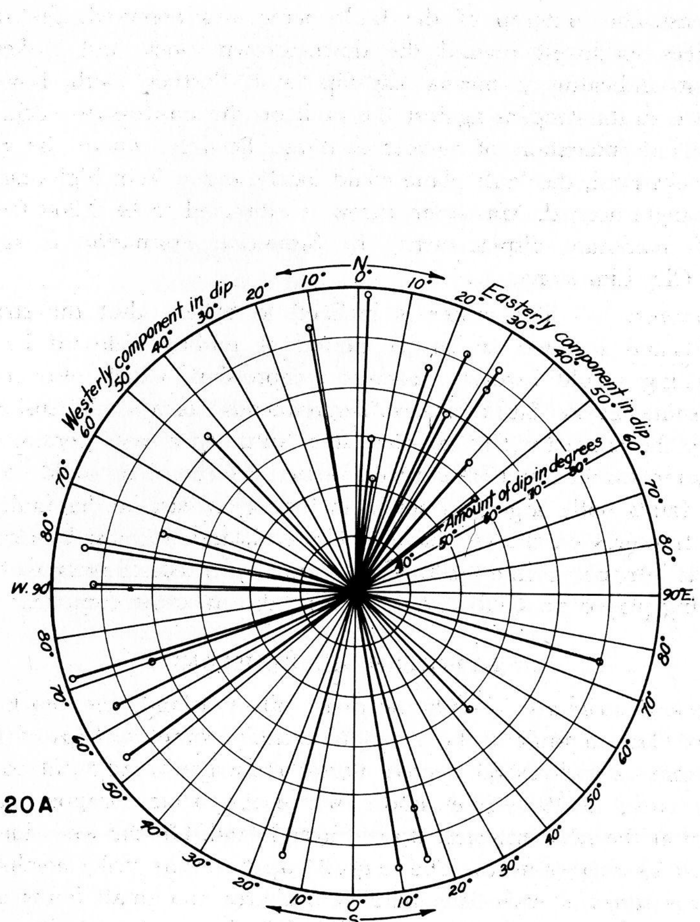


FIGURE 20A

Joints in igneous rocks. The diagram shows a trend towards a northeast joint set dipping southeast.

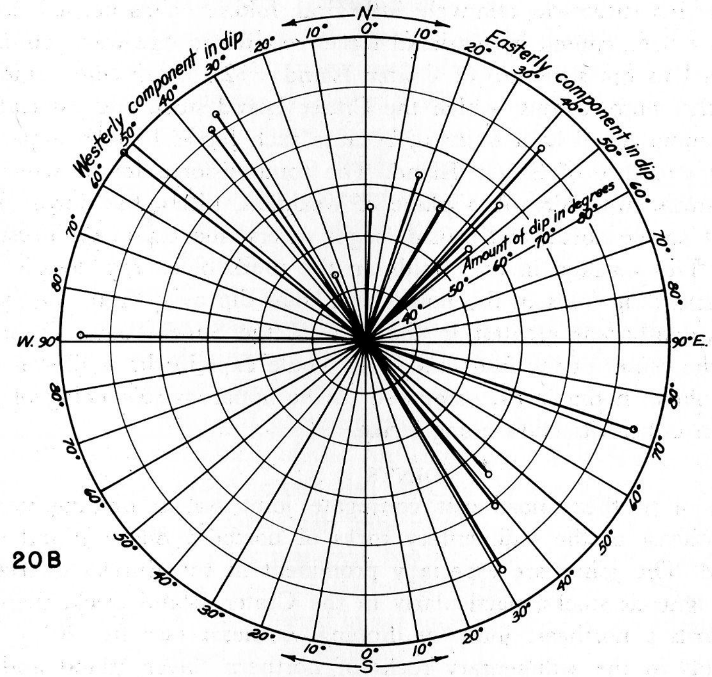


FIGURE 20B

Joints in sedimentary rocks. The diagram shows a northeast-northwest conjugate joint system dipping northeast and southeast.

Joints having dips with an easterly component are shown at the right, those with a westerly component at the left. Strike direction is measured along the circumference of the circle; amount of dip is measured by distance outward from center of circle.

The fault plane was observed in one locality near the center of the fault line and was found to dip 62 degrees southeast and to strike north 80 degrees east. Farther northeast and southwest along strike, the fault plane appears to steepen somewhat. The fault has an estimated maximum throw of 4,800 feet.

The drag folds in the strata on either side of the fault dip as if faulting had been reverse, i.e., they dip opposite from the normally expected directions (see cross-sections A-A′ and D-D′, pl. 2B). Still, the fault plane appears to dip south, and it appears that only normal faulting could place the Permian and Devonian formations in their present relative positions if the fault plane dips south. This geologic oddity can most logically be explained by the following events in the geologic past: (1) An early period of normal faulting, in which there was relatively little drag folding. This normal faulting could have been caused by tensional forces relative to east-west compression (described in the structure of Crater Island). (2) Later compressional forces from the south, against which the Crater Island stock and associated, unexposed plutons acted as a buttress, because such forces had no apparent effect on the structure of Crater Island. The compressional forces acted on the Lost Canyon fault, already a plane of weakness, tilting the north (Devonian) block to the north, and causing slight reverse movement or thrusting in the fault. This resulted in drag folds on the south block that locally are overturned, and drag folds in the north block that dip away from the fault. The force evidently was greatest in the area of the Silver Island drainage divide near the center of the fault line. This would explain the shallower dip of the fault plane in that area, compared to the apparent steepening of the fault plane in either direction along strike.

JOINTS

There is a northeast-northwest conjugate joint system dipping northeast and southeast in the sedimentary rocks of northern Silver Island and Crater Island. The joints are especially prominent in the Eureka quartzite. Also, in the igneous stocks, particularly in the Crater Island stock, there is a trend towards a northeast joint set dipping southeast (see fig. 20).

The joints in the sedimentary rocks of northern Silver Island and in the Crater Island stock can be interpreted as shear fractures that developed due to the compressive force from the south that caused slight reverse movement in the Lost Canyon fault. This also explains the fractures and small normal faults containing igneous dike rock that are more or less parallel with the northeast joint set, and it explains the presence of northeast-striking dikes in the Crater Island stock.

Possibly the joints on Crater Island north of the Crater Island stock are genetically related to those already discussed to the south, but these joints could also be shear fractures formed by the postulated east-west compression discussed in the section on Crater Island structure.

STRUCTURAL GEOLOGY OF THE CENTRAL AND SOUTHERN SILVER ISLAND MOUNTAINS

By
Frederick E. Schaeffer

TECTONIC SETTING

The tectonic framework which affected the area of the Silver Island Mountains (Wendover area) during the various parts of geologic time is discussed in this section.

During Paleozoic time, the area of the Silver Island Mountains was near the central part of the Cordilleran miogeosyncline and approximately 23,600 feet of Paleozoic sediments were deposited in the area. The westward extension of the Transcontinental Arch shown by Eardley (1951, pl. 3) was located approximately 100 miles east of the Wendover area during Late Devonian time as shown by Rigby (1959). A Late Devonian uplift along this arch also appears to have affected the Wendover area.

From latest Devonian to Early Pennsylvanian time, the main thrust and fold belt of the Antler orogeny was active (Roberts and others, 1958) approximately 100 miles west of the Wendover area. This orogeny also affected the Wendover area.

The Northeast Nevada high was active during Pennsylvanian time and its southeastern margin was near what is now the Crater Island part of the Silver Island Mountains (Steele, 1959a, b). According to Steele (1959b) the Northeast Nevada high may be a continuation of the Antler orogenic belt. Roberts (1960, oral communication) considers this high as a part of the northeast continuation of the Antler orogenic belt. This probable extension of the Antler orogenic belt also affected the Wendover area.

During Late Pennsylvanian time, deformation of pre-Strathearn rocks occurred in the Carlin Canyon area, Nevada, and the North Diamond Range, Nevada, (Dott, 1955) approximately 100 miles west of the Wendover area. The Wendover area was affected in a similar manner by the Northeast Nevada high during this phase of deformation.

During late Mesozoic time, the Wendover area was a part of the eastern margin of the Mesocordilleran geanticline as indicated by Eardley (1951), McKee and others (1957), and Osmond (1960).

The Nevadan orogeny (Late Jurassic and Early Cretaceous) and/or the Laramide orogeny (Late Cretaceous through Eocene time) folded and faulted the Wendover area.

In pre-Humboldt (early late Miocene) time, block faulting created the Miocene areas of deposition in the Ruby-East Humboldt Range (Sharp, 1939), approximately 60 miles west of the Wendover area, and also created basins and ranges in the Wendover area.

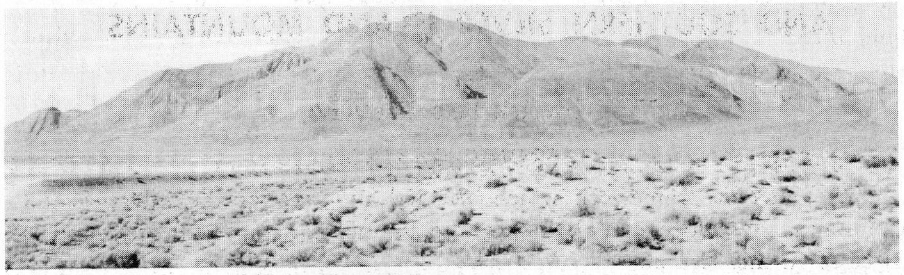


Fig. 21. View looking west of Tetzlaff Peak anticline which trends north. Prominent lake level in background is Provo level. Note Gilbert bar in left foreground.

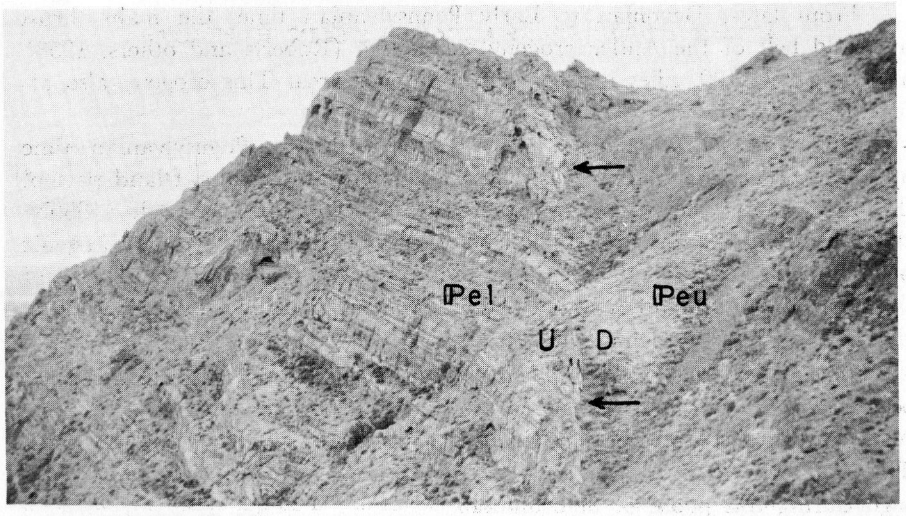


Fig. 22. View looking south on west side of A-1 Canyon in western portion of Leppy Range. Arrows point to a nearly vertical strike fault. Pel, Lower member of Ely Formation; Peu, Upper member of Ely Formation.

During Pliocene time, Basin and Range faulting produced most of the relief of the Silver Island Mountains. Some of the more complete summaries of the theories on the tectonics of Basin and Range faulting are found in Davis (1925, p. 387-388; 1930, p. 293-300), Gilbert (1928, p. 1-9), Nolan (1943), and Eardley (1951). Additional summaries which are rather brief, but important in that they bring the summaries up to date, are Mackin (1960) and Osmond (1960). Gilbert (1874, 1875) first presented the thesis that the ranges in the Basin and Range Province were bordered on one or both sides by profound faults along which elevation had taken place by vertical movements. Since then, many geologists have supported his thesis. Nolan (1943) states that block faulting, as a process, probably began in early Oligocene time and has been more or less continuous ever since. A hypothetical cross section of a typical mountain range in the Basin and Range Province has been drawn by Osmond (1960, fig. 15). This cross section is helpful in understanding the tectonic setting because it indicates that fault blocks may be present under the valley fill, and that block faulting may not be limited to producing topographic ranges. Geophysical studies by Johnson and Cook (1957) appear to support the hypothetical cross section of Osmond (1960).

The area of the Silver Island Mountains was the site of possibly two phases of volcanism and at least two phases of intrusive activity during Cenozoic time. The relationship of the volcanic rocks to a tectonic interpretation of the Basin and Range Province has been discussed by Louderback (1904, 1923), Longwell (1950), and Mackin (1960). Approximately 400 granitic bodies crop out in the Basin and Range Province (Stringham, 1958). The relationship of the intrusions to the tectonic interpretation of the Basin and Range Province has been summarized by Mackin (1960).

FOLDS OF SILVER ISLAND AND THE LEPPY RANGE

Description of folds. — The folds in the Silver Island Mountains have a northward to northeastward trend. The most important folds are the Wendover Peak anticline, Tetzlaff Peak anticline, Lost Canyon syncline, Jenkins Peak anticline, Campbell Peak anticline, Silver Island syncline, and the Cobb Peak anticline. All of the folds plunge in a northerly direction (see pls. 1A and 1B). The Tetzlaff Peak anticline (see fig. 21), Jenkins Peak anticline, Campbell Peak anticline, and the Silver Island syncline trend north. The Wendover Peak anticline and Lost Canyon syncline trend north-northeast. The Cobb Peak anticline trends northeast. All of these folds are well-defined except the Campbell Peak anticline which is a small wrinkle on the broader Silver Island syncline.

Age of folds. — The folds of the Silver Island Mountains developed during two separate and distinct orogenies. The folds in Silver Island, and probably those of the Leppy Range, as well, were initially formed during the Wendover phase (Middle Mississippian) of the Antler orogeny (Sadlick and Schaeffer, 1959) and were subsequently intensified by post-Permian and pre-early Pliocene compressional forces (Nevadan or Laramide orogeny?).

The evidence for the foregoing conclusions is as follows: (1) the post-Joana and pre-Chainman angular unconformity (see fig. 28); (2) the intensity of the folding in the Jenkins Peak anticline and the Cobb Peak anticline is greater beneath the post-Joana and pre-Chainman angular unconformity than above this unconformity; (3) the Campbell Peak anticline and the Silver Island syncline plunge beneath the post-Joana and pre-Chainman angular unconformity (see pl. 1A); and (4) the Lost Canyon syncline which consists of rocks beneath the unconformity is in fault contact with Permian strata which do not appear to be folded.

FAULTS OF SILVER ISLAND AND THE LEPPY RANGE

Reverse Faults

Lost Canyon fault. — General features of the Lost Canyon fault have been discussed in the preceding section of this guidebook by Anderson. The fault is located on northern Silver Island (see pl. 1A).

Anderson interpreted the Lost Canyon fault as a normal fault with subsequent reverse movement. Schaeffer believes the Lost Canyon fault to be a reverse fault with subsequent normal movement. The latter interpretation is made because the Silver Island fault, which is a normal fault, apparently displaced the Lost Canyon fault as shown on the map (see pl. 1A) and cross section (see pl. 1C, section A-A′). This offsetting of the Lost Canyon fault could only be possible if the fault plane of the Lost Canyon fault dips toward the north. Because the drag folds in the strata on either side of the Lost Canyon fault dip as if the movement had been opposite to this direction, the writer believes subsequent normal fault movement occurred along the Lost Canyon fault causing these drag structures to develop. The northward plunging folds may have also influenced the development of the drag structures.

The Lost Canyon fault has an estimated stratigraphic displacement of 6,000 feet.

Jenkins Peak fault. — The Jenkins Peak fault is in the central portion of Silver Island (see pl. 1A). The Jenkins Peak fault strikes north 39 degrees east and dips 55 degrees to the northwest and has an estimated stratigraphic displacement of 2,000 feet. It has been displaced by several later northward-trending internal normal faults.

Age of reverse faults. — The Lost Canyon fault and the Jenkins Peak fault are older than the internal normal faults of the range because they are displaced by the later internal normal faults. The two reverse faults were probably formed contemporaneously. The upthrown side of both faults is on the north. The youngest exposed strata cut by the Lost Canyon fault are Permian in age. This fault does not appear to cut the Salt Lake Group. Therefore, the fault is assigned a post-Permian and pre-Pliocene age. The youngest known strata cut by the Jenkins fault are Silurian in age. The Jenkins fault does not appear to cut the Salt Lake Group. Therefore, it is assigned a post-Silurian and pre-Pliocene age. Both reverse faults may have been formed by the compressional forces of the Laramide orogeny (late Cretaceous through Eocene time).

Normal Faults

Internal faults. — Internal normal faults in the Silver Island Mountains have the following trends: northwest, northeast, north, and east (see pls. 1A and 1B). Stratigraphic displacements vary from a few feet to an estimated 8,000 feet. The fault planes vary in dip from 45 degrees to nearly vertical (see fig. 22). Northeast- and northwest-trending faults predominate. North-trending faults follow in abundance. East-trending faults are least common.

The Silver Island fault on Silver Island and the Tetzlaff Peak fault (see fig. 23) in the eastern portion of the Leppy Range both have an estimatd stratigraphic displacement of 8,000 feet, the greatest displacement observed in the range. Normal faults with stratigraphic displacements ranging from 1,500 feet to 2,000 feet are common throughout the range. The trace of the Silver Island fault is arcuate.

The Cobb Peak fault on Silver Island has had some rotational movement. This fault decreases in stratigraphic displacement from an estimated 3,500 feet to 1,000 feet in a southwestward direction (see pl. 1A).

The central part of Silver Island is a horst structure formed by movement of the block between the Silver Island fault and the Cobb Peak fault. Silver Island Pass is a graben structure located between the Leppy Range and Silver Island (see pls. 1A and 1B) and it also was formed by movement of a block between internal normal faults.

Age of internal normal faults. — The youngest beds that internal normal faults are definitely known to displace are Permian in age. However, the Silver Island fault may have undergone a slight amount of recurrent movement during the Pliocene Basin and Range faulting of the range since the Salt Lake Group is slumped along this fault.

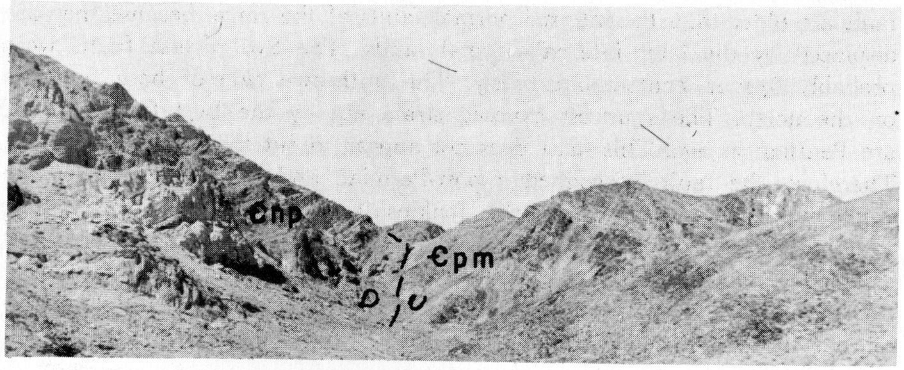


Fig. 23. View looking north of Tetzlaff Peak fault which bisects the Tetzlaff Peak anticline. €np, Notch Peak Formation; €pm, Prospect Mountain Quartzite.

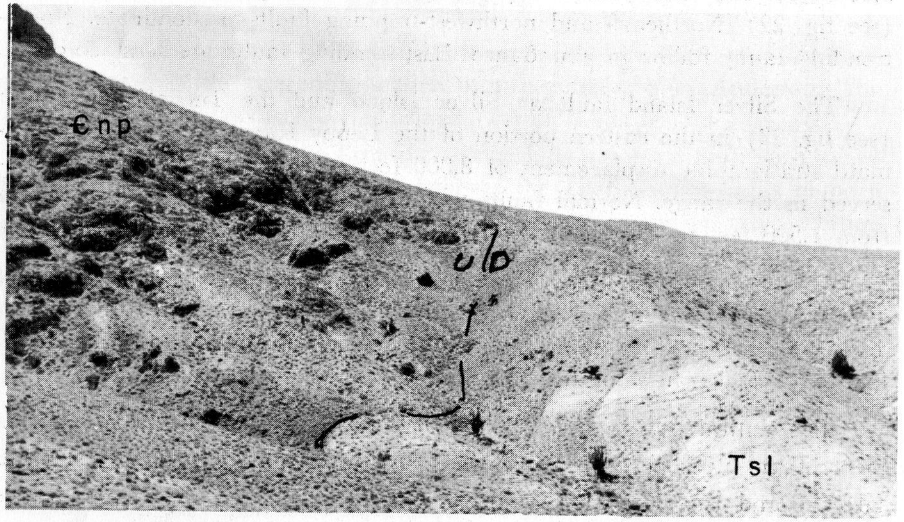


Fig. 24. View looking south at western margin of Silver Island. Salt Lake Group, Tsl slumped against Notch Peak Formation, €np, along Silver Island fault.

Some of the internal normal faults may postdate the early volcanics (post-Permian and pre-early Pliocene?). The foregoing is inferred from the following observations: (1) rhyolite porphyry flows located three miles west of Wendover, Utah, on U. S. Highway 40, dip 26 degrees to the west and rhyolite porphyry flows along the northeast side of the State Line Canyon dip about 32 degrees to the west; (2) some of the fault blocks upon which the rhyolite flows rest may have been tilted toward the west by movement along the northwest-trending internal normal faults which formed the fault blocks; and (3) andesite porphyry #2 dips between 28 and 38 degrees to the west along northwestern margin of the eastern portion of the Leppy Range (see pl. 1B). The dip of the volcanics may be primary rather than structural, in which case the foregoing inference is invalidated. Some of the internal normal faults definitely predate the early volcanics.

These internal normal faults frequently displace folds and therefore may postdate them. The youngest folds are probably Laramide in age, thus the faults are probably post-Laramide.

The internal normal faults may be definitely assigned a post-Permian and pre-early Pliocene age, but as suggested previously, some of the faults may be post-early volcanics and pre-early Pliocene.

Border fault. — A border fault is postulated to parallel the southeastern margin of the range. Physiographic criteria, structural evidence, and well-log information support this interpretation.

Physiographic criteria used to postulate a border fault are as follows: (1) a pediment has developed on the Salt Lake Group along the northwestern margin of the range (see Fig. 25) and this pediment attains an elevation of 1,100 feet above the Bonneville Salt Flats; (2) along the southeastern margin of the range this pediment surface is not present; instead, large alluvial fans have developed; (3) the southeastern margin of the range is nearly straight; (4) the major escarpments face the southeastern margin of the range.

Structural evidence in support of a postulated border fault is indicated by beds of the Salt Lake Group which dip up to 45 degrees away from the Leppy Range along its northwestern margin as a result of tilting of the range to the northwest (see pl. 1B). It seems unlikely that the postulated border could have caused all of the tilting responsible for the dip of the Salt Lake Group; therefore, another block fault is postulated along the northwestern margin of the exposed Salt Lake Group. This postulated block fault possibly dropped the Pilot Valley block down relative to the Silver Island Mountains block. An exception to this attitude of the Salt Lake Group occurs along the northwestern margin of Silver Island. In this area the Salt Lake Group has slumped and rotated until it dips 20 degrees toward the range.

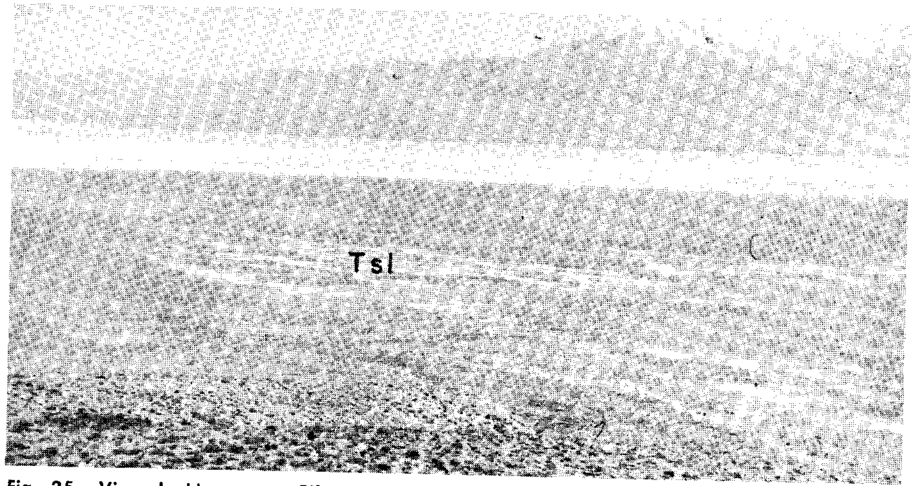


Fig. 25. View looking west, Pilot Peak in background Salt Lake Group (note white areas in foreground), Tsl, exposed beneath pediment surface along western margin of Silver Island.

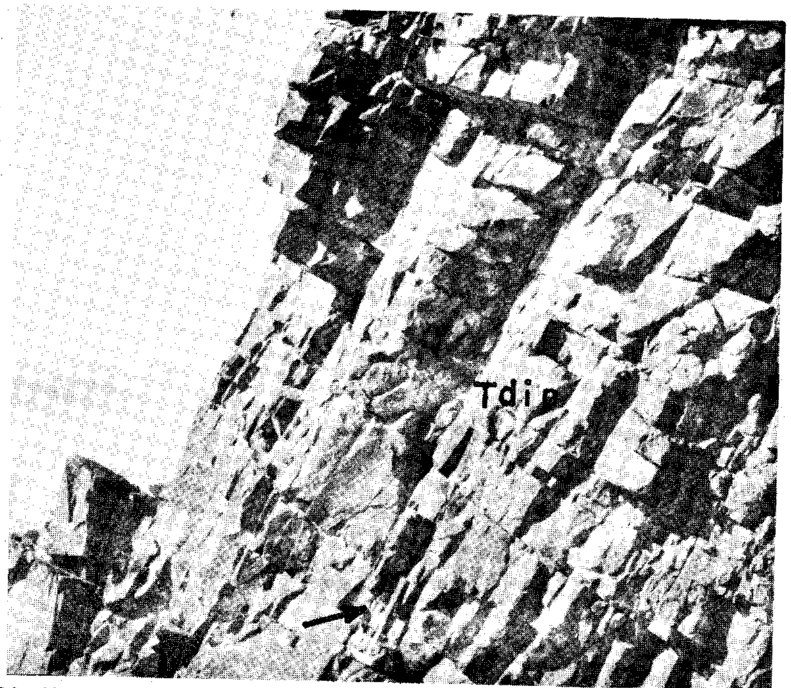


Fig. 26. View looking in eastern portion of the Leppy Range. Well defined joint sets in diorite porphyry, Tdip (arrow points to pick).

The major internal normal faults have a disparity in strike with the border of the range of between 45 and 90 degrees, thus further substantiating the structural evidence for a postulated border fault.

Well-log information from the Shell Oil Company Salduro No. 1 possibly adds support to the postulated border fault. This well is in SE¼ NW¼, sec. 4, T. 2 S., R. 18 W., which is about seven miles southeast of Wendover, Utah. The well-log information from Salduro No. 1 indicates that the Salt Lake Group was encountered at approximately 1,360 feet below the level of the Bonneville Salt Flats. The disparity in elevation between the level that the Salt Lake Group was encountered in the well southeast of the range and the level of the pediment on the Salt Lake Group along the northwestern margin of the range is approximately 2,500 feet. This difference in elevation may be due to displacement along the postulated border fault. However, since the well is located 10 miles from the pediment, this disparity in elevation between the beds of the Salt Lake Group may not bear any relationship to the border fault.

The writer concludes from the foregoing physiographic criteria and structural evidence and well-log information that a northeast-trending border fault parallels the southeastern margin of the Silver Island Mountains. There may actually be a fault zone rather than a single border fault. The presence of Floating Island, which is approximately three miles southeast of the northeastern extremity of Silver Island, indicates a maximum possible stratigraphic displacement of approximately 5,000 feet for the postulated border fault, since such a magnitude would account for the displacement of the Pennsylvanian-Permian beds on Floating Island relative to Devonian beds on Silver Island. However, some of this displacement may be due to older normal faults. The border fault has a minimum stratigraphic displacement of approximately 1,100 feet, as inferred from the difference in elevation between the exposed Salt Lake Group on the northwest side of the range and the Bonneville Salt Flats on the southeast side.

Age of border fault. — The border fault has displaced early Pliocene Salt Lake Group. Late volcanics (post-early Pliocene) rest with angular unconformity upon the Salt Lake Group. Therefore, the age of the border fault is post-early Pliocene and pre-late Pleistocene (Basin and Range faulting).

Post-late volcanics normal faults. — A few normal faults with a maximum displacement of about 10 feet were observed in andesite porphyry # 3, one mile north of Rishel Peak. Andesite porphyry #3 is the youngest flow of the late volcanics; therefore, these minor normal faults reflect the youngest period of deformation in the range (post-early Pliocene).

Paraconformities

Fossil evidence, local discontinuity of thickness of units, and lithologic correlations indicate the presence of the following paraconformities: post-Weeks and pre-Notch Peak; post-"shaly quartzite" member of Eureka and pre-"lower discolored quartzite" member of Eureka; post-Eureka and pre-Fish Haven; post-Fish Haven and pre-Laketown; and post-Laketown and pre-Simonson.

The regional correlations of these paraconformities have been discussed previously in this guidebook (see Stratigraphy of the Silver Island Mountains).

Angular Unconformities

Post-Pilot and pre-Joana. — This unconformity has been discussed previously by Loughlin (1919, p. 36), Calkins (1919, pp. 237-238), Gilluly (1932, p. 22), and Nolan (1935, p. 22). Recently, Brooks (1954) has reported that Joana rests with an angular unconformity upon the Pilot in the north end of the Confusion Range.

The Joana limestone rests with slight angular unconformity upon 425 feet of Pilot Shale in A-1 Canyon, western portion of the Leppy Range, Nevada. In Tetzlaff Canyon, in the eastern portion of the Leppy Range, 72 feet of Pilot Shale are present. At this locality, the Chainman Formation rests with angular unconformity upon the Pilot Shale and the Guilmette Limestone. The angular relationships in Tetzlaff Canyon are in part due to post-Pilot and pre-Joana deformation and in part due to post-Joana and pre-Chainman deformation.

In the saddle immediately north of Silver Peak, Silver Island, the Joana Limestone rests with an angular unconformity upon the Guilmette Limestone. The Pilot Shale is absent at this locality. Approximately 650 feet of strata are truncated between A-1 Canyon and Silver Peak.

On Crater Island, in sec. 11, T. 4 N., R. 17 W., the Chainman and Diamond Peak Formations Undifferentiated appear to rest with an angular unconformity upon the Guilmette Limestone (possible fault contact). The angular relationships at this locality are in part due to post-Pilot and pre-Joana deformation and are in part due to post-Joana and pre-Chainman deformation.

The angular unconformity dated as post-Pilot and pre-Joana may be due to a disturbance related to an uplift of the western continuation (Uinta-Gold Hill arch of Roberts, 1960, in press) of the Transcontinental Arch shown by Eardley (1951, pl. 3). This uplift may be a rejuvenation of the Northern Utah highland of Eardley (1939). The foregoing is inferred because the pre-Joana formations form a homocline which dips to the west (see fig. 27).

Costain (1960) has reported an angular unconformity in the Gilson Mountains, Utah, dated as post-Pinyon Peak and pre-Gilson Chert member of the Fitchville. In regard to this unconformity, Costain (1960) states:

> "It may be evidence for the Early Kinderhook (pre-Madison) epeirogenic uplift of the Transcontinental Arch as postulated by Sadlick (1956, p. 68)."

The angular unconformity reported by Costain is related both stratigraphically and structurally to the post-Pilot and pre-Joana angular unconformity in the Silver Island Mountains.

Post-Joana and pre-Chainman. — The post-Joana and pre-Chainman angular unconformity has been described previously by Sadlick and Schaeffer (1959). Blue (1960) has described a post-Guilmette and pre-Chainman — Diamond Peak angular unconformity in the Pilot Range, immediately west of the Silver Island Mountains, and has suggested that this unconformity may be a result of the Wendover phase of the Antler orogeny.

This angular unconformity is best observed in the saddle immediately north of Silver Peak, Silver Island (see pl. 1A). In this area, the Chainman rests with an angular unconformity upon the Joana Limestone and Guilmette Limestone. The Joana Limestone attains a maximum thickness of 268 feet at some localities in this area, but at other localities within this area it is absent.

The rocks beneath the angular unconformity are more intensely folded than those above. The folds trend north to northeast (see fig. 28). This phase of deformation has been named the Wendover phase of the Antler orogeny by Sadlick and Schaeffer (1959). The "Antler orogenic belt" was named by Roberts (1949a, p. 95) in preference to the name Manhatten geanticline used by Eardley (1947). Many geologists have worked in this orogenic belt in north-central Nevada and for a complete summary of their work and the geology of this area, the reader is referred to the paper by Roberts and others (1958). Sadlick and Schaeffer believe that the Wendover phase (Middle Mississippian) of the Antler orogeny folded the rocks in a belt of the miogeosyncline eastward of the main zone of Antler thrusting shown in figure 6 (Roberts and others, 1958). Subsequently, the clastic rocks of the Chainman and Diamond Peak Formations undifferentiated which originated from the Antler orogenic belt to the west were deposited upon folded older rocks in the Wendover area.

The Wendover phase is dated as Middle Mississippian in age (Sadlick and Schaeffer, 1959). Thus, the age of the Wendover phase of the Antler orogeny occurs within the time interval of the Antler orogeny which is latest Devonian to Early Pennsylvanian in age (Roberts and others, 1958).

Post-Ely and pre-Strathearn. — The post-Ely and pre-Strathearn unconformity has been discussed previously by Dott (1955) and Steele (1959a and 1959b). Dott (1955, fig. 19) indicates the angular nature of this unconformity between Buck Mountain, Nevada, and Tyrone Gap, Nevada, and describes this angular unconformity in the area west from Carlin Canyon, Nevada (Dott, 1955, p. 2255 and fig. 11, p. 2257).

In the Silver Island Mountains, the angular relations between the Strathearn Formation and the Ely Limestone are best observed between Rishel Peak in the Leppy Range and sec. 11, T. 4 N., R. 17 W. in Crater Island (see fig. 29). At Rishel Peak the Strathearn unconformably overlies the Ely Limestone which is 1,741 feet thick, whereas, in sec. 11, T. 4 N., R. 17 W. in Crater Island the Strathearn (occasionally mapped as Diamond Peak by Anderson, 1957) unconformably overlies a quartzite unit of the Chainman Formation. Approximately 2,800 feet of strata are truncated between the two preceding localities.

The post-Ely and pre-Strathearn angular unconformity in the Silver Island Mountains is dated as post-early Desmoinesian and pre-middle Virgilian, based on fusulines identified by Steele (1959b).

Post-Pequop and pre-early volcanics?. — Rhyolite porphyry # 1 and at least a part of rhyolite porphyry #2 and andesite porphyry #2 dip between 26 to 38 degrees towards the west. If this dip is structural rather than primary, these volcanics belong to an earlier period of volcanism designated as the "early volcanics". The early volcanics rest with an angular unconformity upon the Pequop Formation.

All of the other volcanics of the range are nearly horizontal or gently dipping, and rest with angular unconformity upon the Pequop Formation and the Salt Lake Group.

The volcanics which overlie the Salt Lake Group are designated as the "late volcanics". The nearly horizontal volcanics which overlie the Pequop are tentatively assigned to the "late volcanics". If the dip of the early volcanics is primary, then the early and late volcanics are probably closely related.

The early volcanics can be observed at the following localities: along U. S. Highway 40, three miles west of Wendover, Utah; on the northeast side of State Line Canyon; and along the northwestern margin of the eastern portion of the Leppy Range.

The post-Pequop and pre-early volcanics ? unconformity is dated as post-Permian and pre-early Pliocene (pre-Salt Lake Group).

Post-Pequop and pre-Salt Lake Group. — The post-Pequop and pre-Salt Lake Group unconformity was described by Sharp (1939) in his discussion of the Humboldt Formation of northeastern Nevada.

The Salt Lake Group rests with an angular unconformity on Permian rocks in the northernmost and westernmost margins of the Leppy Range. At the westernmost margin of the Leppy Range the exhumed Permian rocks appear as peninsulas and islands surrounded by Pliocene sedimentary rocks.

There must have been a surface with relief in the vicinity of the Silver Island Mountains prior to deposition of the Salt Lake Group. This conclusion is based on the presence of Paleozoic pebbles and cobbles in the Salt Lake Group along the margin of the range on the west side of Silver Island. One of these Paleozoic fragments was found to contain Devonian *Atrypa* sp.

Whether or not a surface with relief was still in existence at the end of the deposition of the Salt Lake Group is not known.

Eardley (1933) advanced the theory "that a submature to mature surface with relief of, at least, 3,000 feet existed in the vicinity of the Wasatch Mountains before the Basin and Range faulting began". Perhaps considerable relief was also present in the vicinity of the Silver Island Mountains before Basin and Range faulting began. If the graben structure which underlies Silver Island Pass is pre-early Pliocene in age, and it appears to be, then 3,000 feet of relief existed in the Silver Island Mountains prior to the deposition of the Salt Lake Group and subsequent Basin and Range faulting.

Post-Salt Lake Group and pre-late volcanics. — The post-Salt Lake Group and pre-late volcanics angular unconformity has also been reported by Sharp (1939) in the vicinity of Contact, Nevada, approximately 70 miles northwest of the Silver Island Mountains.

The late volcanics definitely consist of volcanic breccia, andesite porphyry #3, and at least a part of rhyolite porphyry #2 and andesite porphyry #2. The late volcanics postdate the Basin and Range faulting and rest with an angular unconformity upon the Salt Lake Group.

The post-Salt Lake Group and pre-late volcanics angular unconformity is dated as post-early Pliocene and pre-late Pleistocene.

SUMMARY OF TECTONIC EVENTS OF THE SILVER ISLAND MOUNTAINS

(1) During Paleozoic time, the area of the Silver Island Mountains was a part of the Cordilleran miogeosyncline. Numerous paraconformities in pre-Guilmette time (pre-Middle Devonian) attest to the unstable nature of this geosyncline.

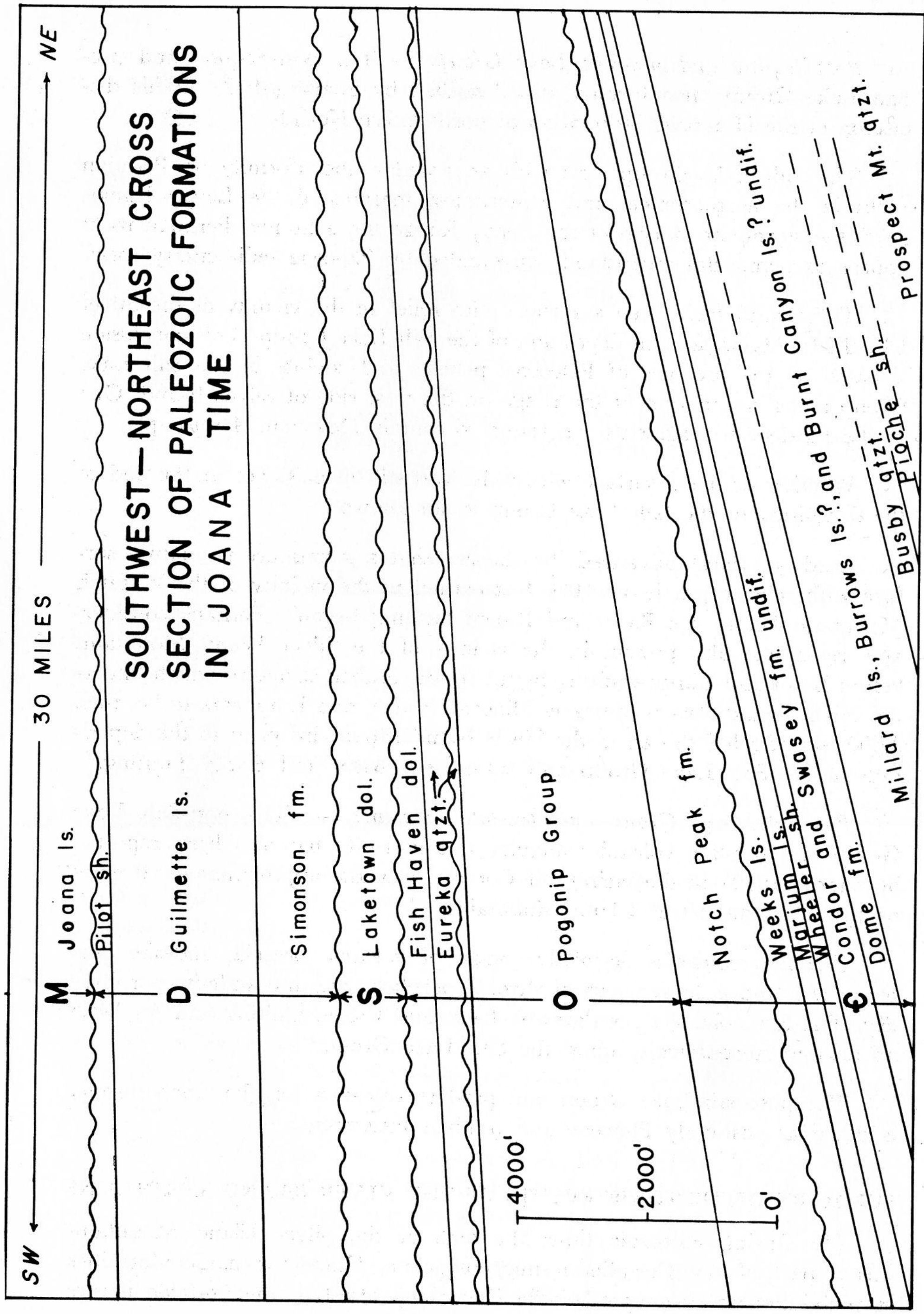


FIGURE 27

(2) In post-Pilot and pre-Joana time (Late Devonian to Early Mississippian), the Paleozoic rocks were tilted toward the west (see fig. 27), due to a disturbance related to an uplift of the western continuation (Uinta-Gold Hill Arch of Roberts, 1960, in press) of the Transcontinental Arch. This uplift may be a rejuvenation of the Northern Utah highland of Eardley (1939).

(3) In post-Joana and pre-Chainman time (Middle Mississippian), the Paleozoic rocks were folded in a general north to northeast trend by compressional forces related to the Antler orogeny to the west (see fig. 28).

(4) During post-Ely and pre-Strathearn time (early Desmoinesian to middle Virgilian), the Paleozoic rocks were tilted toward the south, due to uplift of the Northeast Nevada high (continuation of Antler orogenic belt?) of Steele (1949b) (see fig. 29).

(5) During post-Early Jurassic and pre-early Tertiary time, the Wendover area was uplifted as part of the Mesocordilleran geanticline (Eardley, 1951, McKee and others, 1957, Osmond, 1960).

(6) In Nevadan ? (Late Jurassic and Early Cretaceous ?) or Laramide ? (Late Cretaceous through Eocene) time, compressional forces intensified the earlier north- to northeast-trending folds of the Antler orogeny.

(7) Subsequently, and probably during Laramide ? time, reverse faulting occurred with movement of the upthrown blocks toward the south and southeast.

(8) During the early Tertiary, vertical forces initiated block faulting which has continually occurred since this time to possibly late Pliocene time. This phase of block faulting is represented by the internal normal faults. Some of the normal faults predate the early volcanics and others appear to postdate them. The early Tertiary block faulting created the basins in which Tertiary volcanics and sediments accumulated, and caused ranges to stand with relief which supplied sediment to form at least a part of the marginal facies of the Tertiary rocks in the basins. The general picture was analogous to the scene of today and it was probably repeated several times from its early Tertiary beginning to the present.

Granitic intrusive activity appears to be post-early block faulting and pre-early volcanics in age. Subsequently, porphyry intrusions appear to have intruded the early volcanics, granitic intrusions, and Paleozoic rocks.

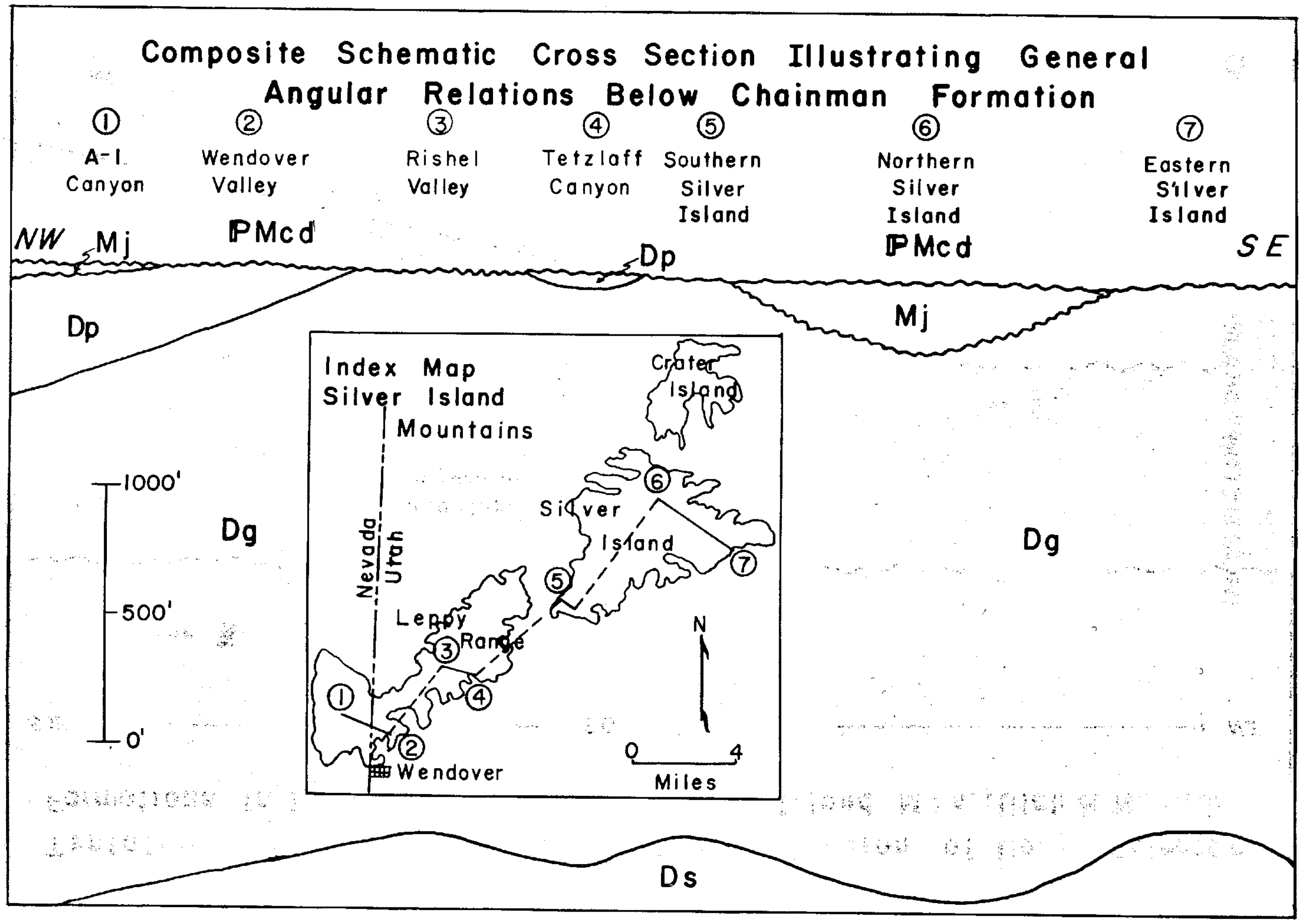


FIGURE 28

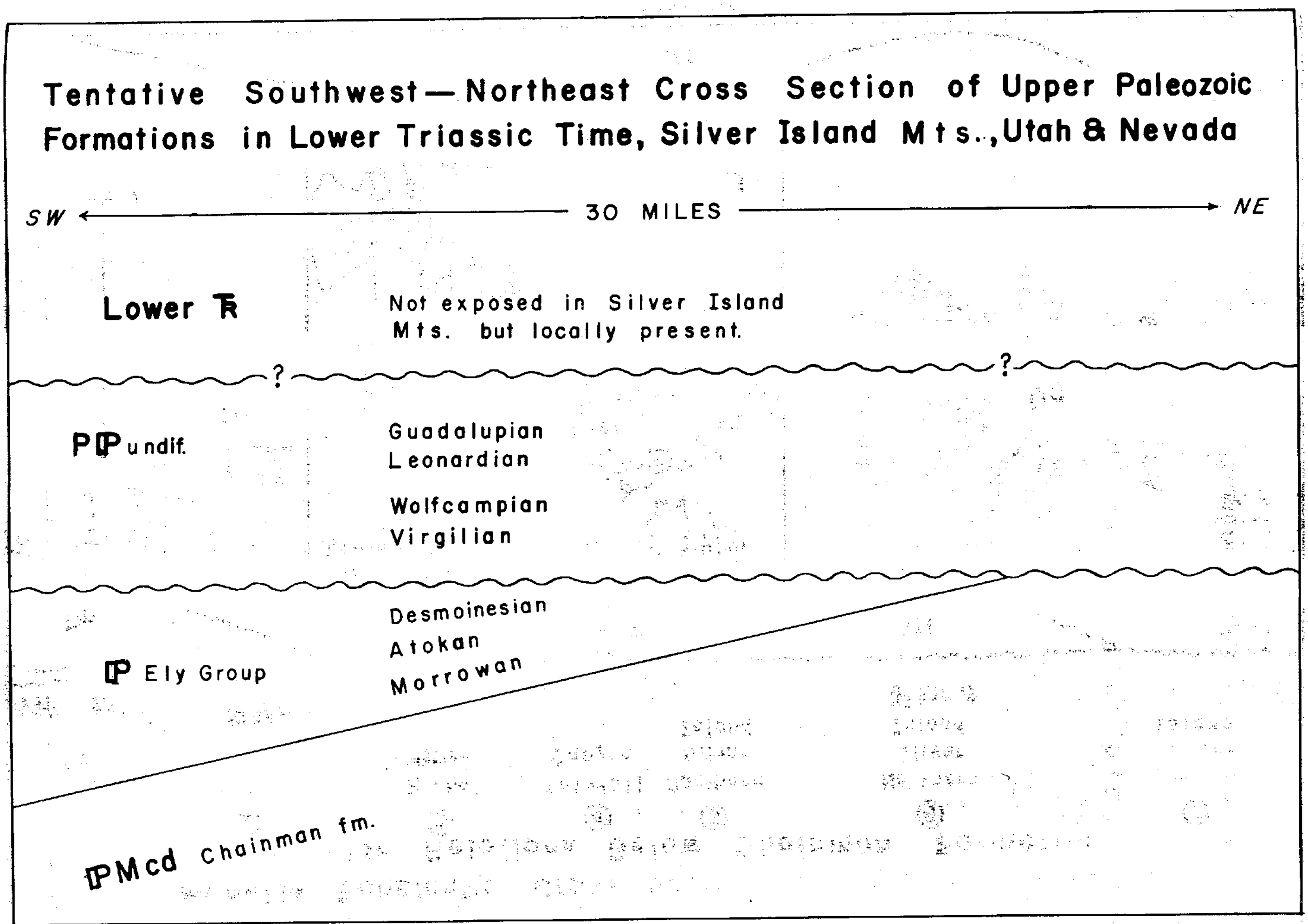


FIGURE 29

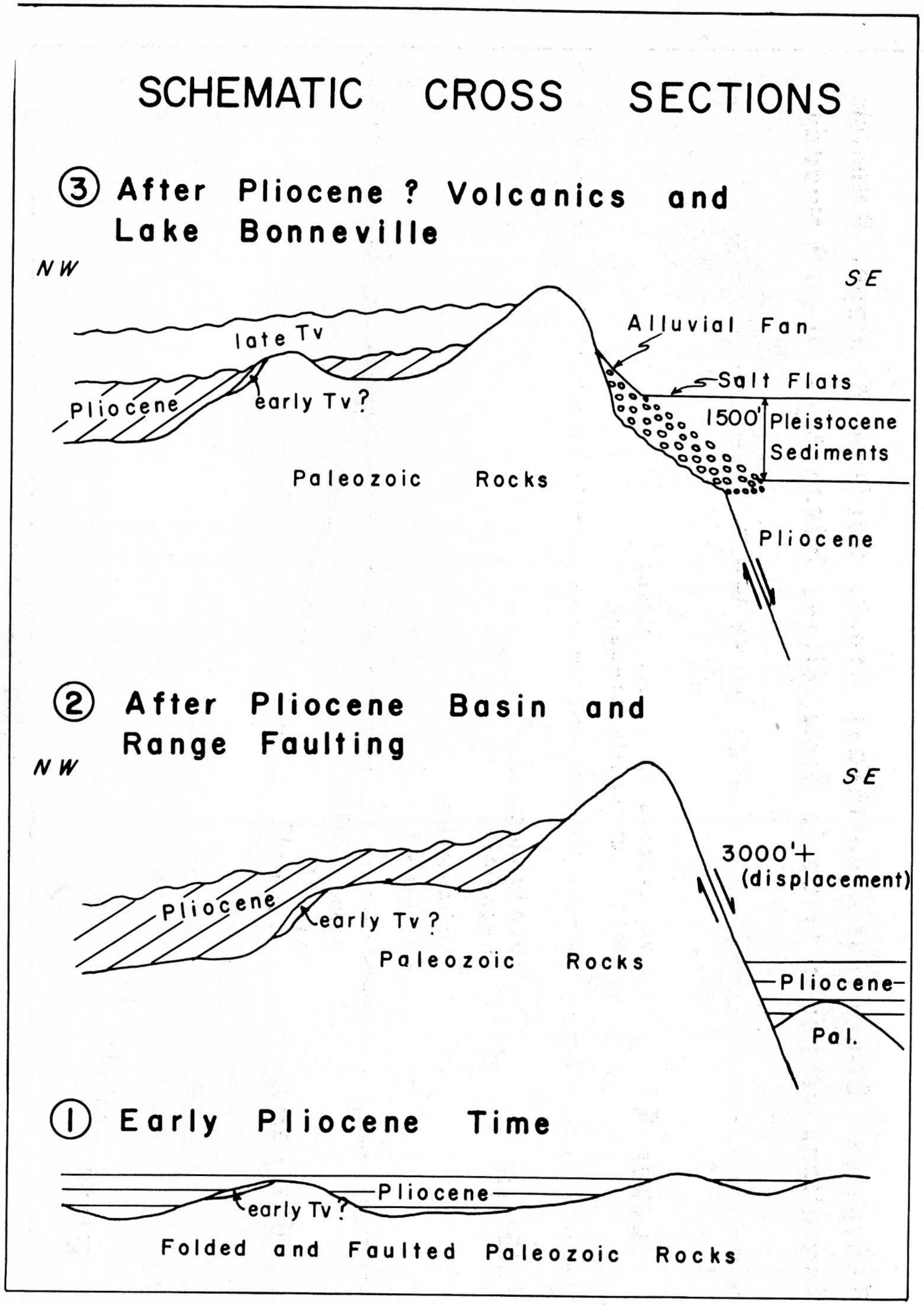


FIGURE 30

(9) Basin and Range faulting (the most recent phase of block faulting), with a displacement of between 1,100 to 5,000 feet, occurred along the southeastern margin of the range after the deposition of the Salt Lake Group (post-early Pliocene), and prior to the extrusion of the late volcanics (see fig. 30). The area of the Bonneville Salt Flats was downfaulted relative to the range which was tilted toward the northwest. Pilot Valley may have been downfaulted relative to the range during this phase of deformation as a result of possible block faulting approximately along the northwestern margin of the exposed Salt Lake Group. A small amount of recurrent movement may have occurred along the Silver Island fault during Basin and Range faulting.

The Silver Island Mountains received most of their relief during the Basin and Range phase of block faulting. This most recent phase of block faulting defined the range into a single structural unit.

(10) Subsequent to Basin and Range faulting, the late volcanics (post-early Pliocene and pre-late Pleistocene) were extruded upon truncated Paleozoic and Tertiary rocks.

(11) Minor normal faulting with displacements of approximately 10 feet followed the extrusion of the youngest flow of the late volcanics.

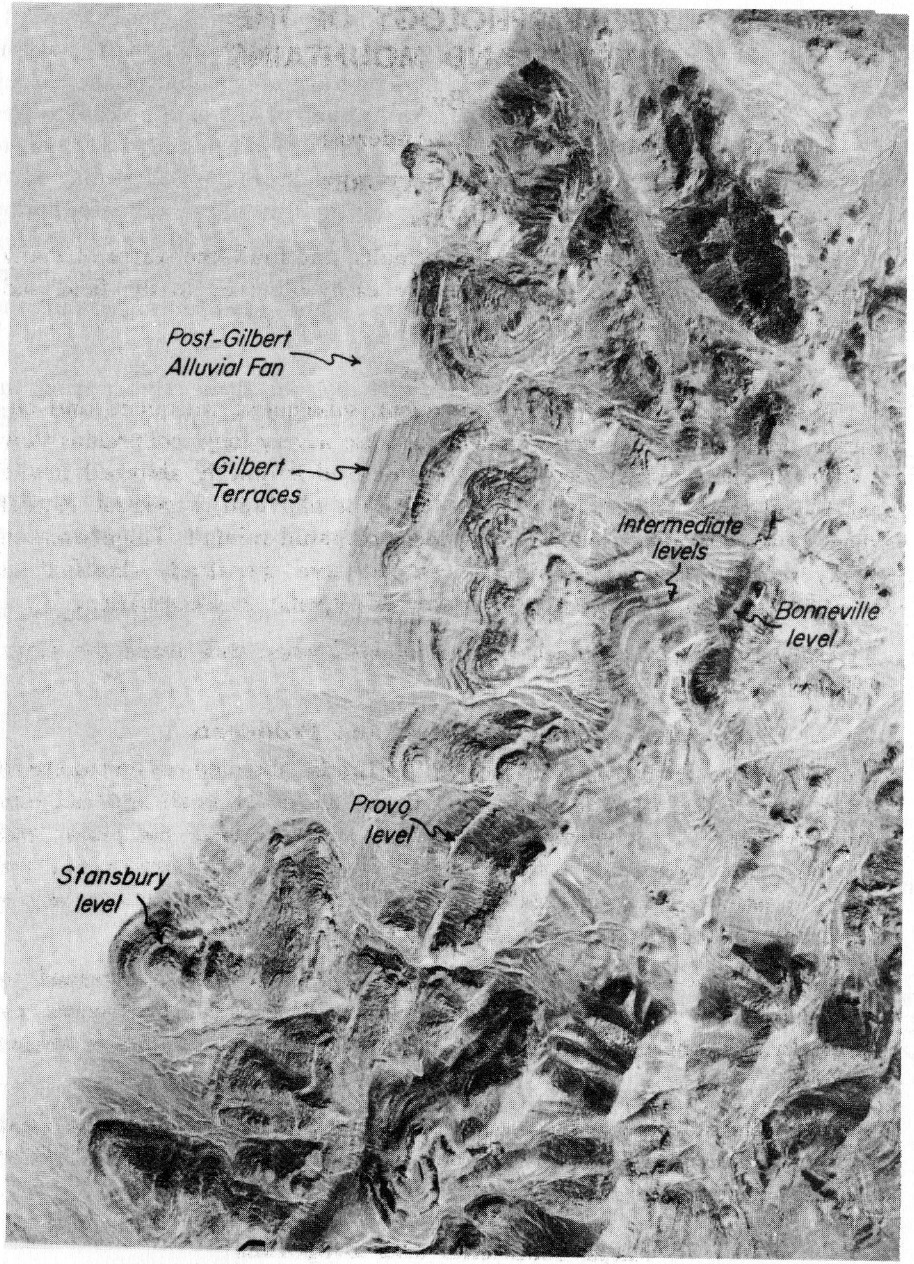


Fig. 31. Aerial view of the northwest Crater Island area, showing the three prominent Bonneville Lake levels, intermediate levels, and Gilbert terraces. Note how the post-Gilbert alluvial fan transects the Gilbert terraces.

GEOMORPHOLOGY OF THE SILVER ISLAND MOUNTAINS

By

Warren L. Anderson

GENERAL FEATURES

Faults

Fault traces of the numerous tension faults, and fault-line scarps of many of the large normal faults in the area are easily observed in the field and located on aerial photographs.

Streams

The streams in the area are consequent, subsequent, resequent, and obsequent. Melting snow is not sufficient to cause a very long, continuous flow of water in the streams; most water thus derived is quickly absorbed in the gravels and sands of the stream washes and the alluvium in general. Actual stream flowage is almost entirely dependent on rapid rainfall. These streams, usually referred to as intermittent, can be more specifically classified as ephemeral streams — those that flow only in response to precipitation.

The large stream channels become braided when they reach the playa or basin flat.

Alluvial Fans, Bajadas, and Pediments

An excellent example of an alluvial fan can be observed on northwestern Crater Island (fig. 31). The alluvial fans are generally small and fall into two categories: (1) those that end abruptly at the edge of the playa; and (2) those that coalesce to form bajadas. Alluvial fans of category (1) are especially noteworthy on the west side of Crater Island. Bajadas can be observed best on the east side of Crater and Silver Islands.

Most of the western edge of Silver Island is a pediment, formed by occasional desert sheet floods, which have great eroding and transporting power. In this zone the access road has been cut by rills and shallow stream channels.

The alluvial fans, bajadas, and pediments contain some original and reworked Bonneville Lake deposits such as lacustrine deposits and small deltas that were deposited in the shore waters of the lake.

Playa Sediments and Evaporites

The Great Salt Lake Desert is described by Worcester (1948) as a good example of a playa. Gilbert (1890, p. 222-223) mentions the playa of Pilot Valley as a type "where water gathers after every storm but does not persist throughout the year.

It should be noted here that the surface and near-surface silts and clays, and a small part of the evaporites are true playa deposits. The much deeper, dark brown to black clays encountered by the drill and mentioned by Nolan (1927) belong to a period of continuous lake deposition by Lake Bonneville, and therefore are not typical of ephemeral lake beds described as playas.

The playa of Pilot Valley was first referred to by Stansbury (1853, p. 109) as a mud-plain. His vivid description (p. 110) of crossing Pilot Valley in the Fall of 1849 could apply equally well at this time. He wrote:

> "The first part of the plain consisted simply of dried mud, with small crystals of salt scattered thickly over the surface. Crossing this, we came upon another portion of it, three miles in width, where the ground was entirely covered with a thin layer of salt in a state of deliquescence, and of so soft a consistence that the feet of our mules sank at every step into the mud beneath. But we soon came upon a portion of the plain where the salt lay in a solid state, in one unbroken sheet, extending apparently to its western border. So firm and strong was this unique and snowy floor, that it sustained the weight of our entire train, without in the least giving away or cracking beneath the pressure. Our mules walked upon it as upon a sheet of solid ice."

Underclay. — The most common sediment in the playa deposits of the Silver Island Mountains area is a fine calcareous clay, which is faintly laminated in a few beds, and is perpetually wet. In fresh exposures the clay is light gray to cream-colored and extremely plastic. Of the other types of clay found, the most abundant are those of a yellow to olive-brown color, and this type was observed by the writer to be prevalent in Pilot Valley. Interbedded sand lenses occur in all proportions in the clays and are limited to near-shore localities (Nolan, 1927).

Saline waters are found throughout the desert within the underclay. The following is an analysis (Nolan, 1927) of a composite sample of underclay brine from the Great Salt Lake Desert:

	Grams per Liter		*Grams per Liter*
Cl	— 96.15	Na	— 57.30
Br	— .00	K	— 2.94
I	— .00	Li	— .002
SO_4	— 4.08	Ca	— 1.51
CO_3	— .00	Sr	— .00
BO_3	— .00	Mg	— 1.91

The potash is commercially recovered from the underclay brines of the Bonneville Salt Flat by Bonneville Potash, Ltd., 3.5 miles east of Wendover.

As observed in Pilot Valley, adjacent to the alluvium the underclay is covered by about two inches of loose silt, which in turn is covered with a thin light brown silty crust. Both the crust and the silt are high in carbonates and NaCl. Locally, during the dry months, portions of the crust may have a slight white color due to the salt content.

Farther out into the basin, the underclay is essentially at the surface. Between these clay beds and the crystalline salt beds is a border zone, narrow in some localities and very extensive in others, where the undrclay is covered with a thin salt coating. Locally, this salt coating is rather rough, explained by Nolan (1927) to be due to the development of miniature thrust faults during the expansion attendant upon crystallization. In this zone the underclay is extremely wet and gummy most of the year, and it is here that Stansbury's mules "sank at every step". During the dry part of the year the salt in this portion is sufficiently dry to blend in with the adjacent crystalline salt flat, giving the salt flat the appearance of being considerably larger than than it actually is. However, during the wet part of the year, or during the dry months after a rain storm, the thin salt layer of this zone goes into solution, leaving a dull gray-brown "mud-plain" adjacent to the true salt flat.

Crystalline salt crusts. — In the Silver Island Mountains area there are two crystalline salt crusts, more commonly known as salt flats. The Bonneville salt flat, several miles south of the area of concern, is estimated by Nolan (1927) to cover 150 square miles. The salt crust thickness there ranges from a feather edge to approximately 3.5 feet. Eardley (1957) estimates the Bonneville salt crust to contain 329,000,000 tons of evaporite material.

Nolan estimates the Pilot Valley salt crust on the west edge of the thesis area to cover 25 square miles, and Eardley estimates it to contain 23,000,000 tons of evaporite material.

The salt is a white, extremely porous, coarsely crystalline aggregate. The surface crust can be in a state of deliquescence or very hard and durable, depending upon the recency of rain, the relative humidity, and the height of the water table. A few inches below the surface, a saturated brine fills the pore space.

Following is an analysis (Gale, 1916) of the soluble portion of the salt crust from the Bonneville salt flat:

	Percent		*Percent*
K	— 0.07	SO_4	— 2.88
Na	— 36.85	Cl	— 58.90
Ca	— 1.20	Co_3	.00
Mg	— .10		100.00

Dunes and Beach Sands

On the north and northwest edges of Crater Island, mound-shaped dunes composed largely of wind-deposited silt may be observed. On the northwest side of the Donner-Reed Pass there are prominent, linear sand deposits up to hundreds of feet in length and trending northwesterly. They are approximately at the Gilbert level. Poor sorting and rounding of the sand particles are indications that these are beach sands that have a very local source and have had little re-working. Their composition points to the Crater Island stock to the north as the source rock. Evidently these beach sands were deposited by prevailing northwesterly currents of Lake Bonneville.

Caliche

Although not exactly a topic of geomorphology, caliche forms observable "crusts" in the area (fig. 33). Talus, fanglomerate, and other alluvial material locally have been cemented by lime to form this highly durable zone of the soil profile that is so common in semi-arid and arid regions.

LAKE BONNEVILLE FEATURES

Evidence of the existence of ancient Lake Bonneville of Pleistocene time is abundant in the northern Silver Island Mountains, and the deposits and land forms here described were made during that epoch.

Terraces

The terraces evidencing lake levels or shore-lines of Lake Bonneville are easily recognized on portions of Silver Island and Crater Island. The three main levels, the Bonneville, Provo, and Stansbury, numerous less prominent intermediate levels, and the lower Gilbert level with associated terraces were observed. Northwest Crater Island (see fig. 31) is an excellent area for observation of these features.

Bonneville level. — The altitude of this shore-line is 5204 feet above sea-level (Schaeffer, 1960), and it is judged to be the highest terrace of the ancient lake (see fig. 32). In this area, the terrace features are not so prominent as those of the lower Provo and Stansbury shorelines.

Provo level. — This level has an altitude of 4834 feet above sea-level (Schaeffer, 1960). Gilbert (1890) noted that the duration of the water stage recorded by the Provo shore was greater than that of the Bonneville water stage, as is evidenced in the area by a much wider, prominent wave-cut terrace at the Provo level (see fig. 32).

This shore-line is characterized by an abundance of calcareous tufa deposits, which make large "reefs" along the terrace edge, and cling to the cliffs or steep slopes immediately below. Some gastropods are present in the tufa.

Talus of boulder, cobble, and smaller fragment size was firmly cemented in the tufa during Provo time. This "conglomerate" was described by Stansbury (1853), who noted its unconformity with the underlying rocks but did not attempt to explain its origin. Tufa fragment debris is so abundant below the various lake levels, especially the Provo level, that the bedrock in some places is obliterated from view for several feet.

Stansbury level. — The Stansbury shore-line has an altitude of 4484 feet above sea-level (Schaeffer, 1960), and it probably ranks next to the Provo in abundance of calcareous tufa. The wave-cut terrace at this level is smaller than that at the Provo shore-line, mainly because the lake was smaller and shallower at this stage, and thus had smaller and less powerful waves.

Intermediate levels. — Several rather prominent, intermediate lake terraces can be observed beteewn the Bonneville and Provo levels on northwest Crater Island (fig. 31). In the same locality and elsewhere in the area, intermediate terraces are present but not so easily discernable between the Provo and Stansbury shore-lines, and between the Stansbury level and the lower Gilbert level. Eardley (1957) has counted 20 intermediate terraces between the Provo and Stansbury, and 19 intermediate terraces between the Stansbury and the Gilbert levels on the Pilot Range to the west.

Gilbert level. — Eardley (personal communication) describes the Gilbert level as the lowest point at which Lake Bonneville maintained a constant level for a relatively long period of time, and he pointed out to the writer a tombolo that was deposited during that time interval. Pebble beaches of the Gilbert level can be observed on the west side of the Donner-Reed Pass between Silver and Crater Islands. The writer has labeled as "Gilbert terraces" (fig. 31) those terraces approximately at the Gilbert level that are a record of the closing event of the Bonneville history, viz., the desiccation of the basin (see fig. 34).

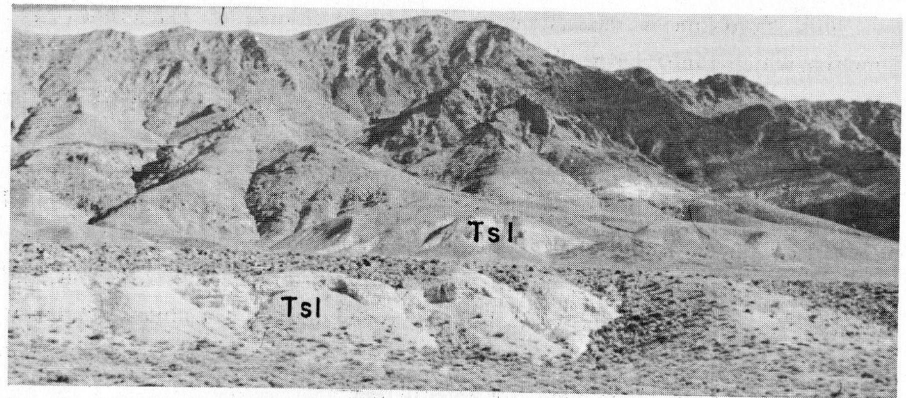


Fig. 32. View looking east, Jenkins Peak in center background. Wave cut cliffs on Salt Lake Group, Tsl; Provo level in foreground and Bonneville level in background at base of wave-cut cliffs (Schaeffer, 1960).

Fig. 33. Deposits of Lake Bonneville, probably of the Stansbury. The lower boulders and coarse gravels are believed to represent the rising lake; the fine diatomaceous layers in the middle were deposited in 50 to 100 feet of water; and the upper sands and gravels represent the subsiding lake.

Diatomaceous Deposits

Whitish colored, powdery deposits varying in composition from calcareous silt containing a low percentage of diatoms to diatomite (over 50% diatoms) occur throughout the area below the Bonneville level. These deposits are especially abundant between the Provo and Stansbury levels, and it is in this zone that the deposits of highest diatom content occur.

Deposits 10 or 20 feet thick still remain in relatively unprotected localities on the mountain sides, in gullies, and on the sides of stream washes, and it is reasonable to assume that at one time the diatomaceous deposits of Lake Bonneville were very extensive and large in the general area, or else such deposits would have been eroded away during the thousands of years since deposition.

Some diatomaceous deposits are bedded, and their depositional gradient is from 10 to 15 degrees, dipping away from the mountains. Two such deposits observed have unconsolidated to poorly cemented sand, gravel, and boulders above and below the diatomite. One of these deposits is shown in figs. 33 and 35. Armand J. Eardley observed the deposit in the field and gave the opinion that it represents a rise and fall in Lake Bonneville, i.e., the lower gravel and boulders represent a low stage in the lake level, followed by a rise in the lake and deposition of the diatomite. This was followed by a lowering of the lake level, deposition of sand, and finally deposition of gravel and boulders again.

Conglomerate and Oölitic Sandstone

Small deposits of lake-deposited, lime-cemented conglomerate containing angular to rounded fragments of grit to medium pebble sizes, and oölitic sandstone in a poor state of consolidation occur at various localities, especially below the Provo level.

Evidence for Prevailing Current Direction

Caves and "saddles" of various sizes were observed in the area. They are predominantly at or close to the Provo and Stansbury levels and face northerly. Pebbles in beaches or spits on the Gilbert level and other rock fragments along the "shore", as observed along southwestern Crater Island, are derived from rock outcrops farther north. These features are interpreted by the writer as evidence of a northerly, probably northwesterly, prevailing wind and current direction during Lake Bonneville time.

Fig. 34 View looking southeast on extreme southern tip of Silver Island. Gilbert bar (Schaefer, 1960).

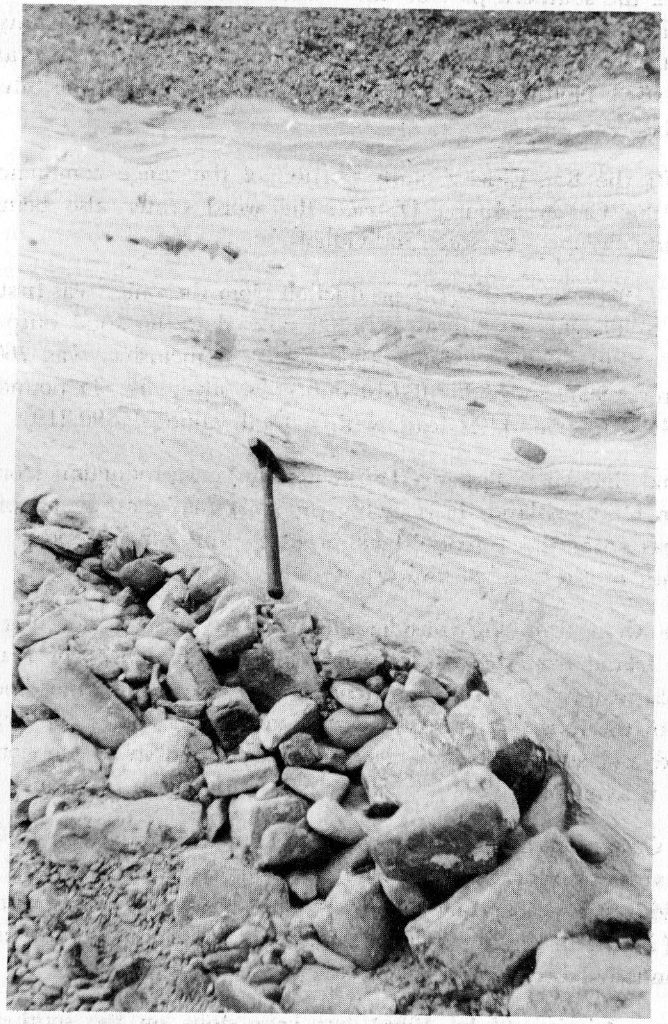


Fig. 35. Close-up view of figure 33.

ECONOMIC GEOLOGY OF THE NORTHERN SILVER ISLAND MOUNTAINS

By

Warren L. Anderson

MINING HISTORY

In 1872 the southern part of Silver Island, Silver Island Mountains was organized into the Silver Islet Mining District. Box Elder County records show that the first claiming activities in the northern part of the range commenced in 1873. Nothing is known of early production from the Silver Island Mountains.

In 1901 the Box Elder County portion of the range commenced to be known as the Crater Mining District, the word crater also being spelled "cratter" and "critter" by some individuals.

Butler (1920) states that the production from the range was first reported to the U. S. Geological Survey in 1908, and that the total output of the Silver Islet Mining District from 1908 to 1913, inclusive, was 760 tons of ore containing $809 in gold, 110,614 ounces of silver, 57,535 pounds of copper, and 414,339 pounds of lead, with a total value of $90,219.

It is not known if Butler's figures include any production from mineral deposits on Crater Island. It is highly probable that most or all of the production was from the Carrie Mack property and other deposits on Silver Island south of the area of concern.

There were times of considerable claiming and prospecting activities on Crater Island from 1873 to World War II as evidenced by a number of abandoned prospect pits, shafts, inclines, and adits at various localities on that part of the range. It is reported that some silver, gold, copper, and lead was mined and shipped from a few of these now abandoned workings, but no record is available.

The Copper Blossom mine (see pl. 2A) was worked for copper ore in the early years of World War II and probably had an earlier mining history. Two buildings now standing, an ore chute, two old building sites, and an old mill (?) site in the area indicate that this was once a sizable installation, since abandoned because of poor economic possibilities.

Recent claiming (July, 1956) has been done on the southern part of the Crater Island stock.

Crater Island

Mineralization on Crater Island is limited to (1) portions of the tactite zone of the Crater Island stock; (2) quartz and calcite veins; and (3) slight random occurrences in the highly jointed Swan Peak quartzite. Some faults show local iron stain and alteration.

Only copper minerals were observed. Hand specimen identification did not reveal the presence of reported silver or lead mineral occurrences, and assays were not made to verify or repudiate such reports.

Mineralized veins. — Two quartz veins and one calcite vein that cut the sedimentary rocks and range in thickness from a few inches to 10 feet were observed in the central Crater Island area. The strike of these veins disassociates them with the joint system in the area. The veins are in independent fractures or small faults of questionable displacement. The longest observed vein exposure along strike was about 300 feet. Copper minerals similar to those at the Copper Blossom mine were observed. Workings, all of which are abandoned, consist of shafts or inclines along vein dips. A short adit has been driven to encounter the calcite vein, and there is a short drift along its strike.

The Sheepwagon stock at the north end of Crater Island is "dry" except for a small four-inch quartz vein in its southwest extremity. Copper minerals similar to those mentioned above were observed.

Copper Blossom mine. — Mineralization at this abandoned mine and associated workings is in the tactite zone between monzonite of the Crater Island stock and Permian limestones. Minerals observed were chalcopyrite, bornite, and chrysocolla.

The main working of the Copper Blossom consists of a short adit to a caved shaft. The surrounding workings consist of two short inclines following the bedding planes of steeply dipping strata, and three shafts of undetermined depth driven approximately at the igneous-sedimentary contact.

The copper mineralization in this area appears to be weak and discontinuous. It is probably post-igneous. The Crater Island stock itself apparently is "dry".

Eureka? Quartzite occurrence. — The southern-most outcrop of the Eureka Quartzite on Crater Island has two fairly deep shafts and evidence of other prospecting activity. Slight surface coatings of chrysocolla were observed on some of the rocks removed in sinking the shafts. Since no veins were observed, it is likely that the prospecting activity was to encounter the mineral in greater concentrations at depth. This venture met no apparent success.

Silver Island

Northern Silver Island is completely lacking in mining claims or any sort of mines or prospects. No mineralized veins or outcrops similar to those on Crater Island were observed.

Barite vein. — A vein of barite was observed on northwestern Silver Island. The vein ranges from a few stringers to a width of approximately 2.5 feet, and crops out for about 75 feet. The economic possibilities of this barite deposit are rather poor, in view of the thinness of the vein, the distance (approximately 20 miles) to the railroad over a rough road, and the lack of water. Inclined drilling would reveal the characteristics of the vein at depth and thus help determine its true value.

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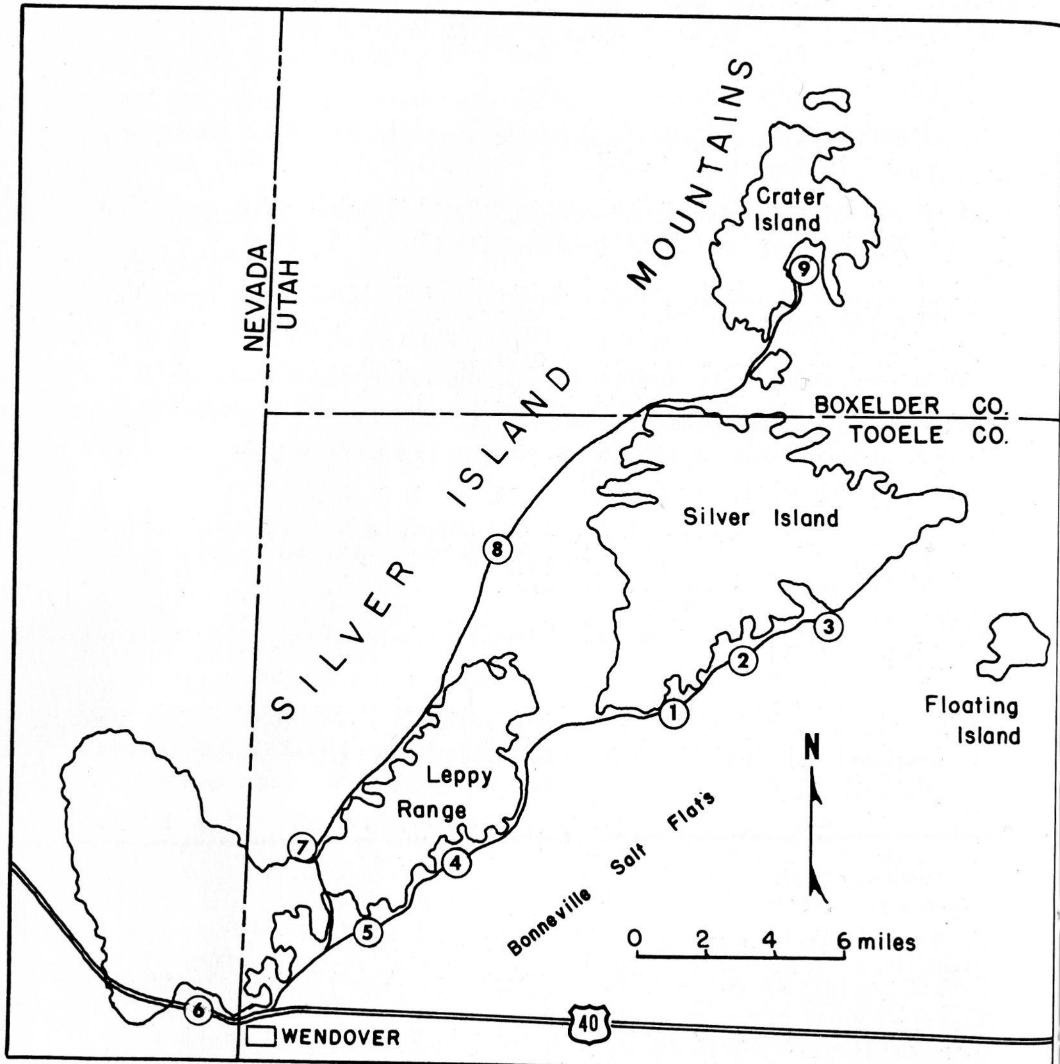

FIGURE 36. Route Map of the Road Log.

ROAD LOG

By

Frederick E. Schaeffer

Miles

0.0 Wendover School on U. S. Highway 40, 50. Proceed east on U. S. Highway 40.

0.5 Turn left (north) on gravel road. Devonian Guilmette Limestone (gray) on left.

1.4 Devonian Guilmette Limestone (gray) on left.

1.6 Danger cave on left in Devonian Guilmette Limestone. Archaeological locality. Indian culture dated back to 11,450 years before present by carbon-14.

2.1 Jukebox cave on left in Devonian Guilmette Limestone about halfway up hill. Archaeological locality.

2.8 Take right fork of road.

4.0 STOP 5. Look toward 7 o'clock; lower lake level is Stansbury (4484′), upper lake level is Provo (4834′). Lake levels are cut in Upper member (orange-brown) of Pennsylvanian Ely Formation. At 8 o'clock Lower member (gray) of Ely Formation overlain by Upper member. At 10 o'clock in background rhyolite porphyry #2 unconformably overlies Permian Pequop Formation (orange siltstone interbedded with gray limestones). At 10 o'clock in foreground are Pleistocene Lake Bonneville deposits (white). We are standing on an alluvial fan.

4.6 On left, Upper member (orange-brown) of Ely Formation.

4.8 On left, Rhyolite porphyry #2 (red) unconformably overlies Permian Pequop Formation (orange siltstones interbedded with gray limestones).

5.5 to 6.6 Devonian Guilmette on left.

8.0 STOP 4. At 9 o'clock note Devonian Guilmette in foreground. Valley beyond underlain by Mississippian-Pennsylvanian Chairman and Diamond Peak Formations undifferentiated. Mountain (Rishel Peak) in background consists of Lower member (gray) and Upper member (orange-brown) of Ely formation unconformably overlain (near top of mountain) by Pennsylvanian-Permian undifferentiated sequence (Strathearn through Pequop).

9.6 On left, north-trending Tetzlaff Peak anticline. At 9 o'clock, Cambrian Weeks Formation overlain by Cambrian Notch Peak Formation. At

10 o'clock, Cambrian Prospect Mountain Quartzite which is in fault contact with preceding sequence.

9.9 Take left fork. Proceed with CAUTION!

10.6 Cambrian Prospect Mountain Quartzite on left. We are driving north on east flank of north-trending anticline.

11.1 Note quartz veins (white) near top of mountain on left.

11.4 SLOW, avoid holes in road.

12.4 At 9 o'clock note bronze-colored Cambrian Millard Fm. at base of mountain. Take right fork. Leaving Leppy Range.

13.3 At 9 o'clock in the background rhyolite porphyry #2 (red-brown) overlies Pliocene Salt Lake Group (orange). In foreground gray outcrops are Permian.

13.9 SLOW!

14.9 Fault on left. Devonian Guilmette Limestone on west side and Cambrian Notch Peak Formation on east side. Note Gilbert offshore bars on right (4251′).

16.0 Silver Island mining district in Cambrian Notch Peak Formation on left. Note mine dumps (reddish gray) on high cliffs.

17.6 STOP 1. Look on left at high mountain in center view, from base to top the stratigraphic section is as follows; Cambrian Dome? Formation to top of first white band in covered interval, Cambrian Condor and Swasey Formations undifferentiated to top of the massive cliff, Cambrian Wheeler Shale forms first slope with brown ledges, Cambrian Marjum Limestone (gray cliffs), Cambrian Weeks Formation (white marker unit at base overlain by second slope), Cambrian Notch Peak Formation forms massive gray limestone cliffs to top of mountain.

18.4 On left same sequence as STOP 1.

19.6 STOP 2. At 7 o'clock Cambrian Notch Peak Formation forms a massive gray dome. From 7 o'clock to 9 o'clock is a stratigraphic section of the Pogonip Group (Ordovician) as follows: Upper Cherty member of the Garden City Formation forms cliffs of Jenkins Peak, Kanosh Shale forms brown slope on top of mountain and along skyline, Lower Limestone member of the Garden City Formation forms steep slope on spur at about 8 o'clock, Lehman Formation is at base of orange marker bed at 9 o'clock. Preceding section has been faulted. Orange marker bed at 9 o'clock is Eureka Quartzite (Ordovician) which is

overlain by massive black Ordovician Fish Haven Dolomite (includes slope at top of formation). At 9 o'clock Silurian Laketown Dolomite overlies Fish Haven Dolomite. Laketown Dolomite is layered light- and dark-gray and forms cliffs and ragged slopes to top of mountain. At 10 o'clock Silver Peak, base consists of banded ledges of Devonian Simonson Fm. and top consists of gray cliffs of Devonian Guilmette Limestone. Bonneville Salt Flats on right. John Cobb set world record for the two-way mark on the Bonneville Salt Flats in 1947 driving his Railton-Mobil Special 394.2 miles per hour. Mickey Thompson set the world record for the one-way mark on the salt flats in 1960 driving his Challenger I 406.6 miles per hour which exceeded Cobb's one-way mark of 403 miles per hour.

20.1 At 9 o'clock in foreground Upper Cherty member of Garden City Formation.

20.9 At 9 o'clock Ordovician Eureka Quartzite (orange) at base overlain by Ordovician Fish Haven dolomite (black cliff and slope) which is overlain by Silurian Laketown dolomite (light- and dark-gray banded dolomites). Gilbert bars on right (4251′).

21.3 Devonian Guilmette (massive gray cliffs) at 9 o'clock.

21.9 Road forks. Take left fork and pull forward until last car can back into right fork. STOP 3. At 12 o'clock (direction before road forks) Silurian Laketown at base of mountain (ragged weathering light- and dark-gray dolomites) on axis of northeast-trending anticline from 12 o'clock to 11 o'clock; Devonian Simonson Formation (layered ledges of dolomite and limestone) overlies Laketown; Devonian Guilmette Limestone (massive gray cliffs) overlies Simonson. Floating Island on right consists of Pennsylvanian and Permian strata. Last car in column will back into right fork and become first car. Proceed to STOP 4 at 35.8 and STOP 5 at 39.8 and Wendover school on U. S. Highway 40, 50 at 43.8.

0.0 Wendover School on U. S. Highway 40, 50. Proceed west on U. S. Highway 40, 50. Devonian Guilmette on right contains a brown quartzite unit which may be correlative to the Stansbury Quartzite.

0.4 Nevada-Utah state line. First transcontinental telephone line was completed at this point on June 17, 1914.

0.5 Devonian Guilmette Limestone on right and left. Note slickensides, and calcite veins on left.

0.8 Turn right at A-1 Club on old Highway 40 and proceed west on old Highway 40.

1.0 At 3 o'clock is a small exposure of Devonian Pilot Shale (light brown) at base of mountain.

1.5 STOP 6. From east to west on right side of road stratigraphic section is as follows: Devonian Guilmette Limestone at 6 o'clock; Devonian Simonson in foreground at 5 o'clock and Pennsylvanian Ely Formation in background (brown); Devonian Guilmette at 3 o'clock; between 3 and 2 o'clock in valley are Devonian Pilot Shale, Mississippian Joana Limestone, and Mississippian-Pennsylvanian Chainman and Diamond Peak Formations undifferentiated; isolated small hill at 2 o'clock in valley consists of Chainman and Diamond Peak Formations undifferentiated; mountain in background at 2 o'clock consists of Pennsylvanian strata on cliff and Permian on dip slope; at 1 o'clock rhyolite porphyry #2 overlies rhyolite porphyry #1; white hills in foreground at 1 o'clock are Pleistocene Lake Bonneville deposits; at 12 o'clock rhyolite porphyry #1 on right and left side of U. S. Highway 40. From roadside park on U. S. Highway 40 at 11 o'clock the curvature of the earth can be seen. Toana-Goshute Mts. at 10 o'clock. Tertiary (?) volcanics at 9 o'clock. Deep Creek Range at 8 o'clock, Dutch Mt. on north end (Gold Hill). We are on an alluvial fan. Return to Wendover.

0.0 Wendover School on U. S. Highway 40, 50. Proceed east on U. S. Highway 40, 50.

0.5 Turn left (north) on gravel road.

1.6 Potash plant on right side of road about 2 miles distant (Bonneville Ltd.).

2.8 Take left fork.

3.8 On left, Upper member (orange-brown) of the Pennsylvanian Ely Formation.

4.1 On left, Lower member (gray) of the Pennsylvanian Ely Formation at base of mountain.

4.2 Wendover water reservoir on left. Water piped by gravity flow from Pilot Range.

4.6 Pleistocene Lake Bonneville deposits (white) in foreground on right.

4.8 Rhyolite porphyry #2 on right and Provo level (4834′) tufa deposits.

5.9 Take left fork. Gravel pit in Provo bar on left.

6.1 Permian outcrop in foreground on left.

6.3 Note jointing in rhyolite porphyry #2 on left.

6.7 STOP 7. Look due west. In distance the flat-topped ridge is composed of Pennsylvanian and Permian strata repeated by faulting; in the foreground are hills of Permian strata. Bonneville Lake level (5204′) near base of hills. To the northwest is the Pilot Range which consists of Precambrian, Paleozoic and Tertiary rocks. In the background toward the northwest is the Toana-Goshute Range.

Look east toward the Utah portion of the Leppy Range; Volcano Peak consists of rhyolite porphyry #2 (red); Rishel Peak consists of Pennsylvanian and Permian strata.

Look east toward Silver Island. White band is lower portion of Cambrian Weeks Formation. From south to north on Silver Island; first peak consists of Cambrian Notch Peak Formation, second peak (Jenkins Peak) consists of Ordovician Pogonip, third peak (Silver Peak) consists of Devonian Guilmette Limestone, last peak consists of repeated Devonian strata.

Low mountains due northeast on Crater Island which consists of Cambrian through Permian strata. Low hills between Crater Island and Pilot Range are on Lamay Island and consist of Permian strata. Grouse Creek Mountains are in background. Pilot Salt Flats are between Silver Island Range and Pilot Range.

Profile of Abraham Lincoln facing skyward can be seen on Silver Peak; eyebrows to north and beard to south.

Take right fork and proceed eastward. We are driving on Provo bar.

7.1 Provo lagoon on right.

7.3 Intersection, continue eastward.

7.4 Take left fork.

7.7 Keep left.

8.0 Rhyolite porphyry #3 in foreground on right.

8.4 Black unit on right at base of rhyolite porphyry #2 is vitrophyre.

9.5 At 1 o'clock note profile of Abraham Lincoln facing skyward on Silver Peak (Devonian Guilmette).

10.5 Andesite porphyry #3 in foreground on right. Permian Pequop on dip slope of Rishel Peak in background on right.

10.9 Andesite porphyry#1 (light-gray to light reddish-gray) on left.

11.9 On right along ridge in background is altered Pennsylvanian Ely Formation (white bands). At base of ridge is altered Permian strata (white bands).

12.8 On right side of road is post-early Pliocene volcanic breccia.

13.2 At 1 o'clock volcanic breccia rests with angular unconformity on early Pliocene Salt Lake Group (light-orange). At 2 o'clock diorite porphyry stock intrudes altered Pennsylvanian Ely Formation (white). Prominent lake level in this view is Provo (4834′).

14.6 Driving on Pliocene Salt Lake Group. On right mountain consists of Permian Pequop.

15.3 On right tombolo connects Permian (right) with volcanic breccia (left). The tombolo is an intermediate level between Stansbury (4484′) and Provo (4834′) levels. Leaving Leppy Range and entering Silver Island Pass which is a graben.

18.5 STOP 8. Stratigraphic section of Silver Island from south to north along ridge is as follows: Cambrian from base of mountain to base of Jenkins Peak, note white marker bed (lower Weeks Formation); Ordovician Pogonip Group from base of Jenkins Peak to first saddle, section is faulted; black formation in saddle is Ordovician Fish Haven Dolomite; Ordovician Eureka Quartzite (orange) immediately underlies Fish Haven dolomite; above the Fish Haven is a faulted section of Ordovician Pogonip Group, Eureka Quartzite, and Fish Haven Dolomite; banded (light- and dark-gray) Silurian Laketown Dolomite overlies Fish Haven Dolomite on first peak north of saddle; Silurian Laketown Dolomite and overlying ledge-forming Devonian Simonson Formation comprise dip slope of first peak north of saddle; north of dip slope is Silver Peak (7300′) which consists of cliffs of Devonian Guilmette Limestone, dip slope of Silver Peak is also Devonian Guilmette Limestone; saddle north of Silver Peak consists of Mississippian Joana, and Mississippian-Pennsylvanian Chainman and Diamond Peak Formations undifferentiated; low mountain immediately north of this saddle consists of Pennsylvanian and Permian strata; north of this sequence is a fault transverse to the crest of the range; northernmost peak on Silver Island is Devonian.

To south in foreground is early Pliocene Salt Lake Group (white and yellow exposures) and a pediment has been formed on the surface of the Salt Lake Group. To north in foreground is a large area of low hills which consist of Permian strata. The Permian strata are separated from the main ridge of Silver Island by the north-trending Silver Island fault. Pleistocene Lake Bonneville deposits are near the road.

22.8 In right foreground at base of mountain is Ordovician Eureka Quartzite (orange) which is overlain by Fish Haven Dolomite (black). Cave is in Silurian Laketown Dolomite. Peak to north is Devonian.

24.5 On right, 50 feet from road, are barite veins (white).

27.0 Leaving Silver Island. Entering Donner-Reed Pass. In September, 1846 the Donner party crossed this pass on their way to California.

27.3 Take left fork.

27.6 Keep left.

28.2 Entering Crater Island. Quartz monzonite and monzonite stock on both sides of road.

29.0 Newfoundland Range in distance due east; mainly Paleozoic rocks with intrusion on north end.

30.6 Keep on right fork.

31.2 STOP 9. At 3 o'clock is Desolate Point; its southern part consists of a granodiorite stock and its central part is Ordovician Eureka Quartzite. At 2 o'clock is Ordovician Eureka Quartzite. In background from 2 o'clock to 1 o'clock is Ordovician Pogonip Group. At 12 o'clock are Devonian strata (gray) overlain by Mississippian-Pennsylvanian Chainman and Diamond Peak Formations undifferentiated (dark brown slope-former). At 11 o'clock first cliff overlying Chainman and Diamond Peak Formations undifferentiated is Pennsylvanian-Permian Strathearn Formation. From 11 o'clock to 9 o'clock in background are Permian strata which consists of clastic-carbonate facies, carbonate facies with unnamed dolomite. In foreground at 9 o'clock is Mississippian-Pennsylvanian Chainman and Diamond Peaks Formations undifferentiated (dark brown). Cars will take left fork until last can can back into right fork. Last car will then back into right fork and become first car. Proceed to U. S. Highway 40, 50 at 61.9.

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